A Text message Intervention to support MEdicines adherence mobiLised through community pharmacY (TIMELY)

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Abbreviations

A-SRHI	Automaticity subscale of the Self-Reported Habit Index
ACT	Asthma Control Test
AIDS	Acquired Immune Deficiency Syndrome
BCW	Behaviour Change Wheel
BCT	Behaviour Change Technique
BGM	Blood Glucose Monitoring
BMI	Body Mass Index
BMQ	Beliefs about Medicines questionnaire
BP	Blood Pressure
BPI	Brief Pain Inventory
CCT	Controlled Clinical Trial
CD4	Cluster of Differentiation 4
CI	Confidence Interval
CMO	Context-Mechanism-Outcome
COM-B	Capability, Opportunity and Motivation for Behaviour
COPD	Chronic Obstructive Pulmonary Disorder
CSS	Cardiac Symptoms Survey
DBP	Diastolic Blood Pressure
EMI	Ecological Momentary Interventions
EMM	Electronic Medication Monitoring
ERD	Electronic Reminder Device
ES	Effect Size
FOMM	Four Or More Medicines (service)
GD	Gemma Donovan
GP	General Practitioner
HAART	Highly Active Antiretroviral Therapy

HbA1c	Glycosylated haemoglobin
HCD	Human Centred Design
HCP	Healthcare Professional
HDL	High Density Lipoprotein
HIV	Human Immunodeficiency Virus
IHD	Ischaemic Heart Disease
IQR	Interquartile Range
IVR	Interactive Voice Response
LDL	Low Density Lipoprotein
MAPS	Medication Adherence for Patient's Support
MeSH	Medical Subject Headings
MMAT	Mixed Methods Appraisal Tool
MRC	Medical Research Council
MRCF	Medicines Related Consultation Framework
MUR	Medicines Use Review
MT	Medication Time
NIHR	National Institute for Health Research
NHS	National Health Service
NICE	National Institute of Health and Care Excellence
NGT	Nominal Group Technique
NH	Nicola Hall
NICE	National Institute for Health and Clinical Excellence
NMS	New Medicine Service
NSS	Not Statistically Significant
OR	Odds Ratio
PCPI	Patient, Public and Carer Involvement
PDA	Personal Digital Assistant
PIL	Patient Information Leaflet

PMR Pharmacy Medication Record

PMc Paul McGough

PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PRSB Professional Record Standards Body

PSNC Pharmaceutical Services Negotiating Committee

QOF Quality and Outcomes Framework

RCT Randomised Controlled Trial

S-Map Solutions for Medication Adherence Problems

SAQ Seattle Angina Questionnaire

SBP Systolic Blood Pressure

SD Standard Deviation

SDM Shared Decision Making

SRHI Self-Reported Habit Index

SMBG Self-Monitoring of Blood Glucose

SMS Short Message Service

SRM Self-Regulatory Model

SuMMiT-D Support through Mobile Messaging and dIgital health Technology for Diabetes

STPSO Simple Telehealth Product Support Officer

T2DM Type 2 Diabetes Mellitus

TECS Technology Enabled Care Services

TIMELY Text messaging Intervention for MEdication adherence mobiLised in community pharmacY

TM Text Messaging

UK United Kingdom

WI Wider Intervention

WHO World Health Organisation

Abstract

Nonadherence to medicines continues to be a challenge in healthcare and is further complicated in patients who have multiple long-term conditions (MLTCs). This research aimed to design a new intervention delivering automated two-way text messaging from community pharmacy (TIMELY), to support medication-taking in patients with MLTCs. A co-design approach using the Behaviour Change Wheel (BCW), Human Centred Design, and realistic evaluation, was used to iteratively develop a new complex intervention and associated programme theory for how the intervention may work.

Intervention design started with a narrative synthesis systematic review of automated two-way digital communication with or without wider components such as face-to-face consultations with healthcare professionals. Data extraction included delivery characteristics and behavioural coding of content. These were analysed for impact on clinical, medication adherence, and acceptability outcomes. Results suggested that automated two-way digital communication could improve reflective motivation and promote habit formation for medication-taking. The role of supplementary healthcare professional support was unclear.

Using findings from the systematic review and the BCW, a new intervention concept was designed and communicated in a series of prototypes representing intervention components. Feedback on the prototypes was then gathered from patients and healthcare professionals in five focus groups (n=21) and using modified Nominal Group Technique (NGT) to support a co-design process. The intervention concept was found to be acceptable and useful changes were identified.

A text message library - termed Alice - was then constructed for eight long-term conditions, including: asthma, chronic obstructive pulmonary disease, chronic pain, depression, ischaemic heart disease, heart failure, hypertension, and type 2 diabetes. Delivery

components were also created. These were used to run a small simulation study of the intervention as part of a co-design process with patients (n=8). Feedback was gathered using modified diary-interviews. Amendments to the tailoring and monitoring processes were identified and data indicated that Alice was able to improve motivation for medication-taking, and some contextual factors which may affect this were identified. Findings also provided insight on how to support patient engagement with Alice, including the importance of intervention delivery from a community pharmacy setting.

To co-design pharmacy training for the intervention, prototypes of training components were created and tested in a simulated training event, integrated with a focus group and modified NGT exercise. Pharmacy staff (n=4) found the proposed training helpful and were able to perform most of the required tasks. However, some tasks took longer than anticipated, and findings suggest that training should be expanded to cover some areas in more depth. Tools to support communication between pharmacies and general practice were also co-designed by creating and testing these in a focus group with general practice staff (n=7) and incorporating modified NGT. The tools themselves were broadly acceptable but additional information needs of general practice about the intervention were identified.

The new TIMELY intervention seems to be acceptable to patients and healthcare professionals. TIMELY may particularly benefit patients with MLTCs, though further research is needed to understand who the intervention benefits most and under what circumstances. The co-design process also offers a novel approach for designing similar complex healthcare interventions in the future.

Publications

The following abstracts have been published relating to this research programme:

Donovan, Gemma, Hall, Nicola, Smith, Felicity, Ling, Jonathan and Wilkes, Scott (2018) *Can a two-way automated patient contact intervention improve adherence to medicines? A systematic review.* Pharmacy Practice, 16 (Suppl1). p. 7.

Donovan, Gemma, Hall, Nicola, Ling, Jonathan, Smith, Felicity and Wilkes, Scott (2019) *Co-design of a new text message intervention with patients and professionals to support medicines adherence.* Research in Social and Administrative Pharmacy, 15 (12). e43-e43.

Donovan, Gemma, Hall, Nicola, Ling, Jonathan, Smith, Felicity and Wilkes, Scott (2020) *Co-design of a new community pharmacy delivered text message intervention with patients and professionals to support medicines adherence.* International Journal of Pharmacy Practice, 28 (S1). p. 24.

The following publications have been published relating to this research programme:

Donovan, Gemma, Hall, Nicola, Ling, Jonathan, Smith, Felicity and Wilkes, Scott (2022) *Influencing medication taking behaviours using automated two-way digital communication: A narrative synthesis systematic review informed by the Behaviour Change Wheel.* British Journal of Health Psychology, 27: 861-890

Donovan, Gemma, Hall, Nicola, Smith Felicity, Ling, Jonathan, and Wilkes, Scott (2022) *Two-way automated text messaging support from community pharmacies for medication taking in multiple long-term conditions: A human centered design with nominal group technique development study.* JMIR Formative Research, 6(12):e41735

Chapter 1 Thesis Overview

This thesis will answer the research question: can an intervention be designed which combines automated two-way text messaging and a community pharmacist consultation, to support medication-taking in patients with multiple long-term conditions?

The Introduction chapter will examine the broad role that medicines play in the management of long-term conditions and outline the increasing problem of multimorbidity and subsequent polypharmacy. I will also set out how I approach medicines-taking as a behaviour, and the underpinning behavioural theories that this research will draw upon. I will then explore the evidence for ways in which community pharmacists can support patients with their medications and the potential use of automated two-way text messaging. The chapter finishes with an argument for combining both community pharmacy and automated two-way text messaging to support medicines-taking, particularly in patients with multiple long-term conditions who are self-managing their medication at home.

In the Research Question, Aims and Objectives chapter, I outline the aims and objectives for each of the five work packages included in this thesis: a narrative synthesis systematic review, three focus group packages, and a small live prototyping study which make up a co-design process for a new intervention and its delivery. The Research Methodology chapter describes the methodological underpinning for my thesis including: Scientific Realism, the Behaviour Change Wheel (BCW), and an introduction to Human Centred Design (HCD). I briefly outline the mixed methods approach used in this research programme but more detailed methods are presented alongside their results and a short discussion for each of the work packages in the subsequent chapters.

In the Narrative Synthesis Systematic Review chapter, I describe and justify the approach for finding and selecting literature to inform the subsequent co-design process. I describe how

data were extracted and the process of mapping the interventions within included studies to the BCW. Results are presented which show how behavioural mechanisms and contexts seem to influence medication adherence and clinical outcomes using the studies in the review. I finish the chapter by signposting the reader to how intelligence from the narrative synthesis systematic review has supported the subsequent work packages to develop the new intervention.

The creation of the concept for the new intervention and the study which gained feedback from patients and healthcare professionals is described in Chapter 6. I explain how the prototypes representing different aspects of the new intervention were designed and describe the process of gathering feedback using focus groups with modified Nominal Group Technique (NGT). The results of this feedback are then provided, alongside a critical analysis of this work package. I finish the chapter by discussing how the findings from this study shaped the three subsequent work packages with patients, community pharmacy, and general practice staff.

In the ‘Co-design of intervention delivery with patients’ chapter, I describe how the text message library for the new intervention was created. I also discuss how the prototypes which supported the simulated delivery of the intervention were updated. The modified diary-interview method to gather and analyse feedback from patients during the delivery of a ‘live’ simulation of the new intervention is described. The results from this feedback are presented in terms of both patient acceptability and the possible contexts, mechanisms and outcomes which may be involved in the new intervention. Insights on how patients engage with the text messaging component of the intervention are also provided.

Building on the new intervention design, set out in the previous chapter, I then describe the study which ran a simulated training event for community pharmacy staff to deliver the new intervention (Chapter 8). This was another ‘live’ simulation, but with community pharmacy

staff interacting with the text messaging software, as well as reviewing an eLearning prototype and implementation tool. A focus group with modified NGT method was used to gather feedback and highlighted potential problems with the deliverability of the intervention. However, the study also highlighted how community pharmacies are well placed to provide this new intervention to patients. In the final part of the chapter, I make some suggestions on how the intervention could be modified to improve delivery of the intervention from pharmacies.

The co-design of intervention concept study highlighted the importance of collaboration between community pharmacies and general practices. The 'Co-design of intervention communication with general practice' chapter describes the work package which explored this. The chapter includes a description of the prototypes which were created to represent communication tools for providing information about the new intervention to general practice. The focus group with modified NGT method which was used to gather feedback is then described. Whilst this focus group did not go to plan, it did provide valuable insight into the potential challenges of introducing the new intervention from community pharmacies and working across boundaries in the primary care setting.

The overall discussion chapter summarises what has been learned from the intervention co-design process and compares this to some other programmes seeking to develop similar interventions in the United Kingdom (UK). I also reflect on the strengths and limitations of the intervention as it currently exists. More broadly, the place of the new intervention in the context of healthcare policy is considered. Suggestions for how the intervention should be further developed and evaluated are proposed. The conclusion chapter finishes the thesis with what I feel is my original contribution to knowledge, the development of a novel intervention to support medication-taking for people with multiple long-term conditions which is behaviourally driven and delivered from the context of a community pharmacy.

Chapter 2 Introduction

This chapter introduces the problem which is the subject of this thesis, the challenge of how we support patients to take their medicines as prescribed. It will discuss some of the theoretical models which seek to examine the reasons for medication nonadherence. I then make the case for examining medication adherence using a behavioural lens. The current evidence for how pharmacists can support medication-taking is presented before examining the potential role of technology as a potential addition to pharmaceutical care delivery.

2.1 Medicines for long term conditions

Medicines are the most common intervention to treat, manage or prevent illness[1]. Data from the Health Survey in England found that 48% of adults take at least one prescribed medication and this prevalence rises with age and also increased deprivation[2]. The number of adults with at least one longstanding illness, defined as an illness or health condition lasting or expected to last at least 12 months, was 45% in women and 41% in men according to data from 2017[3].

The Quality and Outcomes Framework (QOF) is a scheme which provides renumeration for general practices in the National Health Service (NHS) to collect data and meet standards in relation to their patient population. One element within the QOF is to create and maintain long-term condition registers which allow national prevalence data to be gathered. Data from the QOF in 2018/19 showed that the long term condition with the highest prevalence in England was hypertension at 14%[4]. This was followed by depression (11%), obesity (10%), diabetes (7%), asthma (6%), chronic kidney disease (4%), cancer (3%), atrial fibrillation (2%) and chronic obstructive pulmonary disorder (COPD) (2%). Cardiovascular and cerebrovascular conditions combined made up 7%. This correlates with data from the England Health Survey which found that the most commonly prescribed medicines for adults were antihypertensives (15%), lipid lowering medicines (for ischemic heart disease) (14%),

analgesics (11%) and antidepressants (10%)[2]. Medicines were also commonly reported to treat respiratory conditions and diabetes[2]. In 2017, the England Health Survey was amended to include chronic pain and discovered that 34% of adults suffered from chronic pain[3] which correlated with both increased age and deprivation status.

2.2 Multimorbidity and polypharmacy

The term multimorbidity was first suggested in 1996[5] however it has received increased attention since the publication of prevalence data in the Lancet in 2012[6]. The work by Barnett et al.[6] demonstrated a steady rise in multimorbidity with age, from 5.7% in those aged 25-44 to 30.8% in those over 85 years. Multimorbidity has also been linked to poorer quality of life[7], poorer physical functioning[8], increased hospital admissions[9] and higher healthcare costs[9,10]. People with multimorbidity also pose greater challenges to the organisation of care, as most pathways are designed around individual long term conditions[9,10].

Within multimorbidity itself, work has been done to examine whether there are specific long-term conditions that are more likely to be co-prevalent. The work done by Barnett et al.[6] started this by highlighting a substantial co-prevalence of physical and mental health conditions. Other research has also found associations between depression and hypertension, arthritis, diabetes and ischaemic heart disease[11,12]. Other studies of multimorbidity have found hypertension to be commonly clustered with diabetes, osteoarthritis and coronary artery disease[11,13]. Chronic pain has been found to be a common co-morbidity of coronary artery disease, diabetes, COPD and cancer[6]. Some common co-morbidities may have pathophysiologic origins. Systemic inflammation in patients with COPD has been linked to co-morbidity for diseases in the cardiovascular, metabolic, psychologic and muscle mass systems[14].

With each long term condition often attracting medicines, the resultant effect is patients managing multiple medicines, which has been labelled 'polypharmacy'[1]. Although definitions of polypharmacy vary greatly[15], it is generally regarded as a scenario where patients take at least two medications for long term conditions[1]. In 2016 it was found that 24% of adults were taking at least three medicines, and this figure increased with age and deprivation status[2]. Whilst polypharmacy can be appropriate to meet health outcomes for patients, there is also widespread acknowledgement of inappropriate polypharmacy[15,16]. Inappropriate polypharmacy refers to the continuation of medicines when they either no longer provide benefit, or expose patients to potential or actual harm[16]. High quality medication reviews have been suggested by many as the key to ensuring appropriate polypharmacy, which meets the needs of patients and minimises harm[16]. Once polypharmacy has been evaluated to be appropriate, then medication adherence is important to ensure that the desired health outcomes are achieved.

2.2.1 Medication adherence

Medication adherence has been defined as 'the extent to which a patient's behaviour matches agreed recommendations from the prescriber'[17]. The term has evolved from the word 'compliance'[18] which has now become associated with paternalistic models of medicine, whereby patients were expected to 'comply' with treatment recommendations without question. Medication adherence sets itself apart from 'compliance' with its emphasis on shared decision making (SDM) between the patient and the professional making the treatment recommendation[17]. The concept of SDM is closely aligned with that of 'concordance' which was created as a result of work conducted by the then Royal Pharmaceutical Society of Great Britain in 1997[19]. Concordance refers to the process by which shared decisions about medicines are made, and the extent to which the patient and the healthcare professional are able to reach a mutually agreed decision[20]. As concordance is not an outcome with respect to medicines-taking, the National Institute of Health and Care Excellence (NICE) have adopted 'medication adherence' as their preferred term[17]. The ABC

taxonomy of medication adherence separates out medication taking across stages of medication taking including: initiation, implementation, persistence and discontinuation[21]. Initiation is the process of starting medication taking, where this fails to occur this is also sometime referred to as 'primary' non-adherence. Implementation refers to the execution of medication-taking and persistence is the ongoing 'execution' of medicines adherence[21]. Discontinuation is the ceasing of the medication-taking behaviour. There is growing popularity for the term 'persistence' as it moves the emphasis away from an assessment of medicines-taking at a single point in time to a much longer period.

Rates of medication adherence vary between medicines and long-term conditions[22]. The World Health Organisation (WHO) estimated that between 30% to 50% of long term medicines are not taken as prescribed[23] for individual long term conditions. The impact of this medication nonadherence is far reaching, in terms of both clinical and economic consequences. Loss of therapeutic effect can lead to a range of health consequences potentially requiring further intervention and leading to both a clinical and economic cost[24]. Improving medication adherence alone has been shown to decrease mortality rates in hypertensive patients[25] and reduce hospitalisations in patients with asthma[26].

There are fewer data available on medication adherence in polypharmacy, this is in part due to the additional challenges of measuring adherence in this context[27]. Some studies however, suggest that polypharmacy and multimorbidity are predictors of nonadherence[28,29]. One qualitative study also found that patients taking medicines for multiple long term conditions may alter their medicines-taking for different long term conditions at different times[30].

The reasons for medication nonadherence are complex. The World Health Organization (WHO) described five dimensions of adherence in their report on medication adherence[23]. These were health system factors, social and economic factors, therapy-related factors,

patient-related factors and condition-related factors. Reasons for nonadherence have also been categorised into 'intentional' and 'unintentional' reasons[31]. Unintentional nonadherence describes a state where a patient wants to adhere to their medicines as prescribed but is prevented from doing so. Intentional nonadherence is where a patient actively decides to not take a medication. Intentional nonadherence has also been described as 'intelligent' noncompliance, to reflect that this decision has been made based on a rationale which makes sense to that patient[32].

2.2.2 Medicines-taking as a behaviour

This research will examine medication-taking through a behavioural lens. One of the first pieces of work to explain medication nonadherence within a behavioural framework was using the Self-Regulatory Model (SRM)[33]. The model proposed a dynamic framework in which patients act as 'active problem solvers' to reconcile known illness to achieve improved health. It describes three stages of this reconciliation process including 'cognitive representation' of the illness as a threat, the generation of an 'action plan' or coping strategy, followed by appraisal of that action plan based on experiential feedback. Leventhal and Cameron (1987) also highlight that each of these stages may be influenced by emotional reactions which may affect the cognitive processes that underpin each stage. One of the options as part of an individual's coping strategy would be the use of medication, however the SRM model highlights that use of any medication is underpinned by cognition of the illness for which medicines are prescribed, and an evaluative assessment of the benefit of these medicines, including the involvement of emotional processes.

Robert Horne[34] used the SRM as a basis for describing treatment beliefs. Figure 1 reproduces the diagrammatic representation of the SRM along with Horne's additions for treatment beliefs[34], with arrows representing the cognitive processes described in the SRM and Horne's additions relating to treatment. Horne's work used qualitative studies to examine the influences of treatment beliefs on medication-taking and developed four

constructs of treatment perceptions; overuse of medicines and harm caused by medicines as general perceptions; specific beliefs about necessity and concerns for patients' own prescribed medicines. These constructs were translated into the Beliefs about Medicines questionnaire (BMQ) which was subsequently tested across a range of patient cohorts for those taking medicines for long-term conditions[34]. The BMQ contains 20 items spread across the four constructs, which are rated on a five-point Likert scale from 'strongly agree' to 'strongly disagree'[35]. Each of these can then be scored using a scale of 1 (strongly disagree) to 5 (strongly agree) to quantify each of these constructs, with higher scores in the concerns scale indicating higher concerns, and higher scores in the necessity scale suggesting higher perceived necessity for medicines.

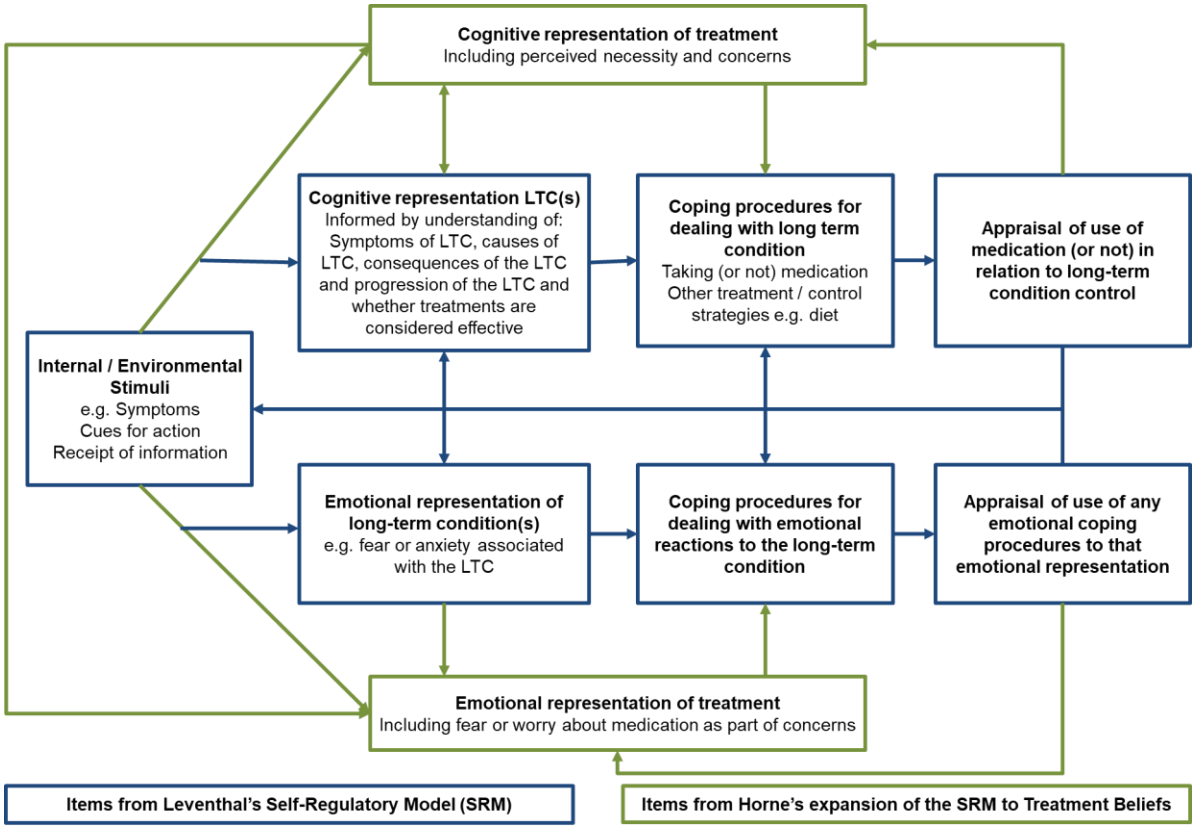


Figure 1 Diagram showing Leventhal's Self-Regulatory Model and Horne's Treatment Beliefs

Administration of BMQ found that general perceptions of medicines overuse and harm were positively correlated with specific concerns about individuals' own medications (Spearman's correlation r=0.5 for harm to specific concerns, p<0.001 and r=0.4 for medication overuse,

p<0.001)[34]. This study found that specific concerns about an individual's medication was negatively correlated with self-reported medication adherence (Spearman's correlation r= -0.35, p<0.001). This has subsequently been confirmed in a meta-analytic study which found that across 89 studies, the 'concerns' subscale of BMQ had a mean effect size correlation of -0.18 (95% CI -0.21 to – 0.15, p<0.0001)[36].

Initial studies of the BMQ, found no statistically significant correlation between necessity beliefs and self-reported adherence[34], however the recent meta-analysis found that this element of the BMQ was positively correlated, finding a mean effect size of 0.17 (95% CI 0.14 to 0.20, p<0.0001) using data from 91 studies. However, as suggested in both the SRM and the BMQ, perceptions of necessity are likely to be linked to the presence of symptoms for the illness and ability of medicines to modify those symptoms. The absence of either of these makes it more difficult for patients to make sense of the value of medicines in modifying their health[34]. This has been found in sub-group analysis of BMQ studies[36]. Asthma for example showed a much higher correlation with the necessity subscale of BMQ and medication adherence at 0.33 (95% CI 0.26 to 0.41) compared to cardiovascular disease (mean effect size correlation 0.07 95% CI 0.03 to 0.11) and type 2 diabetes mellitus (0.11 95% CI 0.03 to 0.19). However, correlations with concerns remains consistent across therapeutic groups.

Early studies of BMQ also found that concerns about medication and perceived need for medicines seem to be balanced against each other[34]. This theory was described as a necessity-concerns framework[37]. By subtracting the total concerns score from the necessity score, a necessity-concerns differential can be calculated which has a range from -20 to +20 with positive values indicating that an individual's perceptions of necessity outweigh their concerns, and concerns outweighing necessity for those with negative scores. The necessity-concerns differential seems to have a stronger correlation with medication adherence compared to the individual subscales, with the previously mentioned meta-

analytic study finding a mean effect size correlation of 0.24 (95% CI 0.18 to 0.30, p<0.0001) across 25 studies. Use of the BMQ therefore offers not only a way to detect potential medication nonadherence, but also identify perceptual influences on medication-taking decisions.

Reasons for intentional nonadherence have been discussed thus far but causes of unintentional nonadherence also need to be addressed. Horne et al. tackled this by expanding the work on the BMQ into a 'perceptions and practicalities' model[38] combining the influence of medication perceptions with practical ability to take medicines. These behavioural considerations have also been incorporated into the development of a Medicines Related Consultation Framework (MRCF)[39] for consultations to support a patient centred approach to discussions about medicines.

During the development of the BMQ, it was posited that the necessity scale reflected both medication need and medicines efficacy beliefs[34]. The SRM clearly identifies patients' appraisal of their coping strategy as important for patients' coherence of their illness and treatment[33]. The BMQ suggests this appraisal is completed through patients' self-rated health symptom experience within the necessity questions. The subgroup analysis findings that perceived necessity differs by long-term condition provides some evidence for this. However, others have suggested that medication efficacy beliefs need separate assessment using different questions. Phillips et al. [40] in their study of type 2 diabetes patients asked "Have you noticed the positive benefits of the medication?" and "Have you experienced any solid/convincing evidence that the diabetes medication does what it is supposed to do" in addition to the BMQ. Although these items did not correlate with medication adherence in this study, it was also not clear to what extent patient participants were expected to receive this feedback and from what sources. Considering whether medication efficacy beliefs are separate to perceived need is something for further exploration.

The original work on SRM suggested that an individual's representation of their illness and medicines-taking as a coping strategy may be influenced by automatic, that is non-conscious, factors[33]. Phillips et al.[41] highlight the potential for behavioural habit to over-ride reflective decision making as part of illness and treatment coherence. Their study found that habit strength as measured using the Automaticity subscale of the Self-Reported Habit Index (A-SRHI)[42] predicted variance of medication adherence[40] and therefore habit is also likely to be an important influence of medication talking behaviour.

2.2.3 Capability, Opportunity and Motivation for Medicines-taking Behaviour

More recently, use of more generic behaviour models has been suggested as a prism through which medication-taking can be examined. One example of this is use of the Capability, Opportunity and Motivation behavioural model (COM-B) developed by Michie et al.[43]. Capability in this model is subdivided into physical and psychological, opportunity is separated into social and physical, motivation is considered separately for reflective and automatic. The COM-B model has also been mapped to medication-taking as a behaviour[44] and is re-produced in Figure 2.

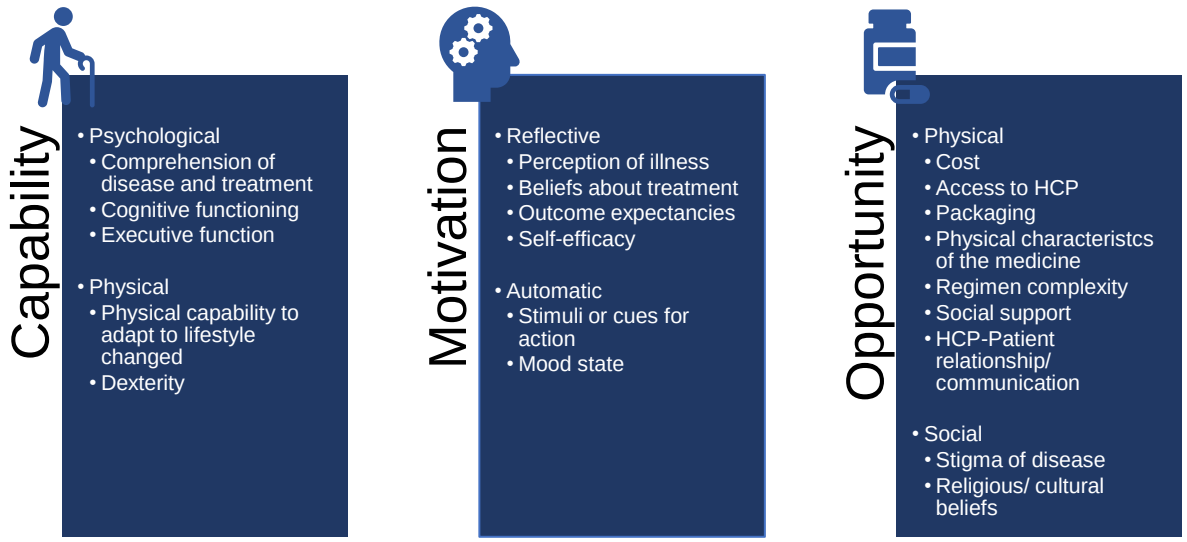


Figure 2 The COM-B model mapped to medicines-taking as described by Jackson et al. (2014)

The mapping by Jackson et al.[44] was based on a review of reported medication adherence barriers. In this model of COM-B for medication adherence, psychological capability relates to a patients' understanding about their illness and their medication, as well as their capacity to plan and remember to take medication. A recent Cochrane review also labelled these as medication-taking 'ability'[45]. However, as illustrated by the work by Horne et al., it should be noted that how medical professionals understand medicines may be quite different to that of how patients understand their medicines[34].

Physical capability relates to how physical characteristics might affect a patient's ability take medication. This includes dexterity issues or potential physical constraints which may prevent them from making lifestyle changes to support their treatment. This is also aligned to some of the 'practicalities' described in Horne's perceptions and practicalities model for medication adherence[38].

Physical opportunity is the accessibility of the environment which enables an individual to engage in a behaviour[43]. In the case of medicines-taking, this includes considering the ease with which patients can access medicines from packaging, use a device or swallow a medicine, and ability to pay for treatment[44]. Medicines packaging in particular has been highlighted as an issue for older people[46]. Physical opportunity also includes access to healthcare professionals, the quality of those relationships and any social support a patient may need to support medicines-taking. Social opportunity relates to the social influences that may affect how people feel about taking medication including the impact of stigma or religious and cultural beliefs.

Reflective motivation consists of the active weighing of benefits and disadvantages surrounding a behaviour which then affects conscious decision making[43]. This includes perceptions of illness and beliefs about treatment, as well as considering experience of

outcomes and beliefs about one's own ability to change the future[44]. This is closely linked to the necessity-concerns framework[36].

Automatic motivation is made up of emotional elements and habits[43]. For medication, this includes the influence of emotions on medication-taking which has also been underlined in the SRM[33] and its extension to include treatment beliefs[34]. The mapping by Jackson et al. also highlights the role depressive disorders have as an independent variable for medication nonadherence in people with chronic illness[47]. Automatic motivation also includes the role of stimuli or cues in the execution of the medicines-taking behaviour[44]. This influence of habit has been echoed in other research as important for medication adherence[41].

COM-B offers a comprehensive model of explaining the factors that influence medication-taking behaviour at both the individual level and in the wider environmental context. It can incorporate understanding from other models but also sheds light on other medication-taking barriers that have been less well examined. COM-B describes capability and opportunity as both influencing motivation and so also highlights that to improve medication adherence, each element may need to be addressed but in doing so may have an additive effect on improving medicines-taking behaviour.

2.2.4 Influencing medicines-taking behaviour

There has been much effort directed at finding interventions to improve medication adherence. In 2014, a Cochrane review of 182 randomised controlled trials (RCTs) found no clear evidence for any specific intervention[48]. However, a subsequent review of medication adherence interventions in older adults[45] found that behavioural interventions, potentially mixed with education, may be able to improve medication adherence and medicines-taking ability.

Increasingly, there have been calls for more personalised approaches to support medication adherence based on behavioural principles such as COM-B[49]. The COM-B model is also part of the Behaviour Change Wheel (BCW) framework[43]. The BCW provides a road map for designing behaviour change interventions through a process of identifying barriers to performing a behaviour using COM-B[50]. One review of behaviour change interventions to influence medication adherence has suggested use of the BCW to develop future behaviour change interventions to support medication adherence[51], however no examples of this existed. The Cochrane review did however highlight the potential of utilising pharmacists and using technology to support medication adherence, though few studies combined the two components.

2.3 Role of pharmacists in supporting medication-taking

Of the studies included in the Cochrane review of medication adherence interventions, 34 involved pharmacists in some way[48]. Twenty nine studies described a pharmacist-led intervention, whilst a further 5 included a pharmacist as part of a multi-disciplinary care intervention. Studies included pharmacists based in community and hospital settings and often took advantage of the close relationship of pharmacists with medication supply.

A separate Cochrane review of medication adherence in older adults with polypharmacy[45] included 50 studies, most of which (n=31) were delivered by pharmacists. Subgroup analysis did not reveal any difference in outcomes between those delivered by pharmacists compared to other healthcare professionals. NICE however, in its review of pharmacist roles in medication review, found that enhanced service provision from community pharmacies was effective at reducing mortality and reducing emergency department attendances[52]. NICE also found pharmacy services to be cost-effective.

The conflict in the evidence is partly due to the inclusion criteria for each Cochrane review, which required that all studies included were of randomised trial design. The review also required studies to include evaluation of both clinical and medication adherence outcomes[48], thus excluding studies which only examined one of these outcomes. Without these criteria, other reviews have concluded that community pharmacists are able to improve medication adherence[53].

2.3.1 Medicines Use Reviews

In 2005, Medicines Use Reviews (MURs) were launched as part of the community pharmacy contract in the National Health Service (NHS)[54]. A MUR was defined as a pharmacist review of the patient's **use** of their medication[55]. This included ensuring that patients knew how to use their medicines, their prescribed indication and identified any issues associated with medicines use[55]. This was the first attempt to move community pharmacists away from dispensing and towards patient-facing activities. Research on the uptake of MURs found that delivery was variable amongst pharmacies, with those under the ownership of chain pharmacies delivering twice as many of those owned independently[56]. Pharmacists in this study also cited a lack of General Practitioner (GP) support and pharmacist confidence in providing the service as barriers to MUR delivery.

More recently, the NHS attempted to increase the value of MURs by mandating targets for delivery in known areas where medication adherence is problematic. This included three target categories; patients taking 'high risk' medicines, those recently discharged from hospital and individuals with respiratory disease[57]. In 2015, patients diagnosed with or at risk of cardiovascular disease, or taking four or medicines were added as target groups[57]. Initially the percentage of MURs required to be targeted was 50% and this was increased to 70% in 2015. Targeting for patients taking high risk medicines or recently discharged were added to the target group in 2019[58].

Formal evaluations of MURs were lacking despite their availability over a long period[59,60]. Most evidence was small scale evaluations without publication in the peer-reviewed literature[57]. A report commissioned to evaluate the value of community pharmacy also found little evidence to support their value to the NHS[61]. One available study of MURs found they had minimal impact on patient use and understanding of medicines and offered little beyond what would be expected as part of routine medication counselling[62]. Other research found that MURs offered reassurance for patients and were valued for this role in supporting medicines-taking[63]. Patient satisfaction with information received about medicines has also been found to be improved in patients who received advanced services in pharmacies such as MURs[64].

MURs have now been decommissioned, with none to be delivered after 2021[65]. A criticism of MURs could be the lack of underpinning theory to support pharmacists and the wider healthcare team to understand the purpose of the MUR. From examination of the suggested questions for pharmacists for a MUR[66] it is clear that a MUR should have the potential to address physical and psychological capability barriers, and explore reflective motivation around medicines-taking. MURs could also address physical opportunity barriers by asking about medication supply[55]. However, if these intentions are not clearly communicated to those delivering the service, then this could lead to inconsistency in how MURs are conducted and ultimately their effectiveness. There has also been little guidance for pharmacists about what actions to take following on from the identification of any issues beyond the provision of information. This may be in part due to the lack of overall evidence about what interventions might work to support people with their medicines-taking.

There is evidence however that outcomes from MURs can be improved if there is more structure, for example, those designed to support inhaler use. A trial service to support patients with COPD found that pharmacists were able to improve medicines-taking behaviour, quality of life and reduce GP visits[67]. In Italy, a version of the MUR for asthma

found improvements in medication adherence and asthma control[68]. In France, pharmacist counselling found an improvement in inhaler technique but not medication adherence[69]. These services seem to address a potentially unmet need to improve physical and psychological capability for use of inhaler devices which pharmacists can deliver.

2.3.2 Community pharmacy support for polypharmacy

Research on new medication support services for use in the NHS has also been conducted. Some of these have been driven by a collaboration of pharmacy chains in the effort for more services to be commissioned from the sector[70]. One such initiative is the 'Four Or More Medicines' (FOMM) service which has been designed to support older patients with polypharmacy[71]. The FOMM service aimed to identify drug-related problems using the validated STOPP/START tool[72], with potential changes to medication discussed with the patient and GP. The intervention also included a discussion of falls risk, pain and regular follow-up[73]. The evaluation of the FOMM service found that it was able to reduce overall risk of falls, improve medication adherence and improve quality of life[74].

A pharmacy care plan service has also been developed and evaluated in community pharmacies targeting patients with cardiovascular disease and diabetes[73,74]. This service delivers a medication review by the pharmacist using the Pharmacy Medication Record (PMR) and evaluation against STOPP/START[72] to evaluate drug related problems prior to a consultation with the patient. This intervention used a coaching approach[74] which has been suggested elsewhere as a potential mechanism to improve the quality of medication counselling[75]. The evaluation found that the service was effective at improving blood pressure control, medication adherence and quality of life[74].

In New Zealand, evidence suggests that community pharmacists can support patients with medication adherence through medication counselling and altering the format in which medicines are supplied[76]. A Spanish medication review service has also been designed for

delivery from community pharmacies, providing a more clinically focused medication review with follow-up in older patients with polypharmacy[77]. The evaluation of this service found significant increases in quality of life and that the service was cost-effective[77].

2.3.3 New Medicine Service

A notable omission from the Cochrane review of medication adherence interventions[48] was the supporting evidence for the New Medicine Service (NMS)[78]. The NMS is a pharmacist-led intervention which takes advantage of the dispensing function of community pharmacists. It is designed to support patients who start a new medicine for a long-term condition. The NMS was designed using the SRM[33] and Horne's work highlighting the role of illness and medication perceptions as influences on patients medication-taking behaviour[37]. The service seeks to evaluate these perceptions and use pharmacist counselling to modify these perceptions. The interaction between the patient and the pharmacist also aimed to identify 'problems' associated with medication-taking and resolve these directly or refer patients back to their prescriber.

Following initial medication counselling, patients receive follow-up telephone calls to ascertain if they have started taking their new medicine and to help with any issues which have arisen. The original study found that patients in the intervention group were less likely to be nonadherent to their medicines (9% in the intervention compared to 16% in the control group, p=0.032) and report medication related issues at follow up. This initial evidence led to national commissioning of the intervention by the NHS as part of the community pharmacy contract[79].

The NMS also successfully impacted patients' perceptions of their medicines. Patients receiving the NMS intervention were found to have a higher median necessity-concerns differential compared to the control group (5 intervention vs 3.5 control, p=0.007)[78]. This suggests that part of the mechanism by which the NMS works to improve medication

adherence is through modification of patients' medication-related perceptions. The NMS has also been shown to be cost effective[80,81].

The initial NMS study included medicines for the treatment of stroke, cardiovascular disease, asthma, diabetes and rheumatoid arthritis as well as any long term condition in patients over 75 years[78]. The service commissioned by the NHS however removed the blanket inclusion of those over 75 years and medicines for rheumatoid arthritis. It also restricted the inclusion of cardiovascular disease to antihypertensive medication only, and diabetes to only Type 2. It did however add anticoagulants, antiplatelets and COPD as additional inclusion criteria for the service[79]. A follow-up RCT was conducted using this version of the NMS and similarly found the intervention to be effective, demonstrating an increase in medication adherence (71% intervention compared to 61% control, p=0.04)[82]. The continued effectiveness of the NMS despite changes in patient population suggest that it is the underlying mechanisms of the service which provide the desired improvements, and that these are transferable to other diseases and medicines.

An implementation evaluation of the NMS[83] found that following large scale roll-out of the service, some elements of the intervention were not fully implemented and that 'buy-in' was variable between pharmacists. The evaluation highlighted the need for further training for pharmacists to support delivery, including communication training. In the original study[78], pharmacists were given feedback on their patient interviews which was not incorporated into implementation, and this was identified as a potential cause of some of the inconsistency. Pharmacist participants in the implementation study[83] also highlighted that there was a lack of awareness about the service from GPs and patients; this subsequently affected how pharmacists viewed the value of the service. The study authors recommended early engagement with stakeholders both within and outside the pharmacy profession when implementing new services from the community pharmacy environment.

The NMS provides a useful example of an effective medication adherence intervention delivered from a community pharmacy setting, and the service itself represents an important step forward in community pharmacists' role as an active actor in supporting patients with medication-taking[84]. As a case study, it also highlights the potential for behaviourally targeted interventions to improve medication adherence delivered from the community pharmacy setting. The implementation of the NMS also highlighted the challenges that context can cause when interventions are transferred from research to usual care delivery.

Since the Cochrane review of medication adherence interventions[48], evidence for the positive impact community pharmacists can make on medication adherence has grown. However, challenges remain around how to mobilise interventions in community pharmacies without large investments in pharmacist time. One opportunity could lie in the other suggested intervention from the Cochrane review[48] – the potential role of technology, and specifically text messaging.

2.4 Role of technology

Several forms of technological intervention were considered as part of the Cochrane review of interventions for medication adherence[48]. These included alarms, telemonitoring, medication monitoring and prompting devices, Interactive Voice Response (IVR), remote internet-based treatment support and Text Messaging (TM). Although the evidence was categorised as weak, the report acknowledged the potential for such technologies to improve medication adherence at population level.

2.4.1 Technology Enabled Care Services

There is a lack of consistent terminology to describe the use of technology for healthcare delivery. The NHS Commissioning Assembly use the umbrella term Technology Enabled Care Services (TECS). However, terms such as telehealth and telemedicine are often used

interchangeably with TECS[85]. The Medical Subject Headings Database (MeSH) uses the Parent term ‘Telemedicine’ and include synonyms for ‘Mobile Health’, Telehealth, eHealth, and mHealth[86]. TECS is usually used to describe the care pathways or functions for which technology is being utilised. Separate terminology can also be seen which relates to the specific hardware or software used to deliver these care pathways. The WHO define eHealth for example as “the use of information and communication technologies for health”[87].

The NHS commissioning Assembly identify TECS as having a potentially important role in supporting the NHS as part of the Five Year Forward View[88]. This includes using TECS for medication adherence. Whilst the evidence which supports this is limited, the potential for TECS to improve medication adherence has been widely considered in literature reviews.

Many reviewers have examined the current evidence for TECS or eHealth strategies[89–98]. Some of these have focused on particular long-term conditions or implementation, based on country income[99], geographical area[100,101] or care setting[102]. Some reviews have concentrated on age groups such as the elderly[103–105] and younger people[106]. A summary of reviews examining TECS for medication adherence can be found in Table 1. Most of these reviews however do not acknowledge the diversity of reasons for why patients may not adhere to their prescription regime[92,107–112]. The most popular technology to support medication adherence seems to be the use of short message service (SMS) or text messages.

Table 1 Summary of literature reviews of Technology Enabled Care Services for medication adherence

Review	No. studies	Population	Technology type	Outcomes of interest	Authors' conclusions
Linn et al. 2011[109]	13	Patients taking medication for a chronic condition	Internet	Medication adherence	No clear relationship between tailoring and impact on medication adherence
Hamine et al. 2015[113]	107	Patients with cardiovascular disease, diabetes, chronic lung disease	Mobile internet, SMS, PDA, apps, video messaging, IVR, EMM, ERDs, Bluetooth devices	Adherence to chronic disease management, disease-specific outcomes, usability, feasibility, patient acceptability, healthcare professional acceptability	mHealth tools have the potential to impact patients less inclined to engage in other services; require an existing adherence programme
Angela-Martinez et al. 2015[114]	20	People taking medication for primary or secondary prevention	SMS, IVR, apps, ERD	Medication adherence, patient acceptability	65% of studies had a positive outcome
Park, Howie-Esquival & Dracup 2014 [115]	29	People taking medication for primary or secondary prevention	SMS (no apps found)	Medication adherence, patient acceptability, feasibility	Studies demonstrate the patient acceptability and feasibility of interventions. Important to consider engagement as part of intervention.
Thakkar et al. 2016[112]	16	Adult patients with chronic disease exc. Psychiatric patients	SMS	Medication adherence, patient acceptability	TM increases medication adherence for middle-aged patients
Wald, Butt and Bestwick 2015[116]	8	Adults with HIV, cardiovascular disease	SMS	Medication adherence	Two-way TM is more effective than one-way
Sarabi et al. 2016[111]	34	People taking medication for chronic diseases	SMS	Medication adherence, morbidity, mortality, hospitalization, clinical outcomes, patient acceptability	Text messages as reminders seem to be effective for increasing medication adherence
Sarkar, Sivashankar and Seshadri 2015[117]	44	People taking medication	SMS	Medication adherence	Text messages offer a promising intervention for improving medication adherence

Review	No. studies	Population	Technology type	Outcomes of interest	Authors' conclusions
Fenerty et al. 2012 [110]	11	People taking medication	Telephone call, IVR, SMS, video messaging, pager, ERDs	Medication adherence	Reminders can increase adherence to medications but should be adjunct to other strategies (e.g. education)
Mistry et al. 2015 [118]	38	People taking medication for a medical condition	Telephone call, email, SMS, pagers, video messaging, internet, ERDs, computer programmes	Medication adherence and patient outcomes concurrently	Evidence for limited effectiveness of technology-mediated interventions, most successful interventions included a non-automated component
DeKoekkock et al. 2015 [119]	13	Adults taking oral prescription medication	SMS	Medication adherence, patient acceptability	TM has the potential to improve medication adherence
Lee et al. 2014 [108]	14	Adults taking medication	SMS	Medication adherence	TM has the potential to improve medication adherence by providing prompts to patients
Fang, Maeder and Bjering 2016 [120]	45	Patients using medication as part of self-care	Telephone calls, SMS, apps, video messages, ERDs	Medication adherence	Electronic reminders can improve medication adherence in self-care settings
Tao et al. 2015 [121]	22	Patient taking medication for chronic diseases	SMS, pagers, ERDs	Medication adherence	Electronic reminders appear to be an effective method of improving adherence to medicines
Granger and Bosworth 2011 [122]	9	Patients taking cardiovascular medication	Telephone, ERDs, IVR	Medication adherence, health service utilisation, health outcomes	Assessment of adherence could be used with technology and in-person contact to support medication adherence
Fjeldscoe, Marshall and Miller 2009 [123]	14	People receiving behaviour change interventions	SMS	Medication adherence, clinical disease control, process outcomes	Tailoring of message content and increased interactivity may improve engagement in behaviour change via SMS
Vervloet et al. 2012 [124]	13	Patients taking medication for chronic disease	SMS, pagers, ERDs	Medication adherence	Electronic reminders improve short term medication adherence. Tailoring and personalised timing may lead to improvements in longer term outcomes

Review	No. studies	Population	Technology type	Outcomes of interest	Authors' conclusions
Ciciriello et al. 2013 [125]	24	People exposed to multimedia interventions about medication	Videos, web-platforms, computer programmes, computer games	Medication adherence, knowledge about medication, skill acquisition in relation to medicine, health outcomes, self-efficacy, adverse medication events, compliance with treatment behaviours, patient acceptability, perceptions of illness, beliefs about medication, use of health services	Multimedia interventions do not seem to influence medication adherence but there is low quality evidence for an improvement in knowledge and skill acquisition compared to written or no intervention. Potentially equally as effective as healthcare professional delivered. May work best as a supplementary component.
Glucose Monitoring; EMM: Electronic Medication Monitoring; ERD: Electronic Reminder Device; IVR: Interactive Voice Response; PDA: Personal Digital Assistant; RCT: Randomised Controlled Trial; SMS: Short Message Service; TM: Text messaging					

2.4.2 Text messaging

The Technology Tracker Survey[126] recently found that 96% of adults in UK personally owned or used a mobile phone with this figure being 100% between the ages of 25-54 and 90% in those who are 55 years and older. The survey also shows that 85% of people who use a mobile phone send or receive text messages[126] and this is high amongst all age groups (55+ = 74%; 35-54 years = 90%; 25-34 years = 90%). This data shows that text messages are used by a wide variety of age groups and therefore provide an accessible option to implement TECS.

With mobile phone use so prevalent, they are a potentially powerful tool to provide Ecological Momentary Interventions (EMIs) such as TM to influence day to day behaviours[127]. EMIs are characterised by the integration of an intervention within an individual's everyday life. To be effective at taking advantage of this however, the design of EMIs is likely to require tailoring, with careful consideration given as to who sends the messages, how and when they are delivered, how often they are sent and what it is they say[128].

In the Cochrane review of interventions for medication adherence, it was TM which was specifically mentioned as having the potential to improve medicines-taking behaviour[48]. Subsequent reviews by Cochrane also examined the impact of TM as a reminder and/or education tool in adherence to inhaled corticosteroids in asthma[129] and lipid lowering medicines[130]. In 2017, a Cochrane review examined TM to support adherence to medicines for secondary prevention of cardiovascular disease[131]. Contrary to the review of interventions for medication adherence, the review for TM for asthma included studies which examined medication adherence and/or clinical outcomes. The analysis found beneficial effects for the use of TM, though highlighted the lack of tailoring for interventions and consideration of factors affecting medication nonadherence[131]. Most review authors examining TM for medication adherence seem to agree that tailoring may improve effectiveness for influencing

medication adherence (see Table 1) but only a small number of reviews have so far specifically examined this.

TM falls within the category of mHealth (or mobile health) which specifically relates to the use of mobile phone devices to support healthcare practice and has been highlighted by the WHO as a potentially powerful tool[132]. Cited evidence to support the recommendations for using TECS in medication adherence by the NHS Commissioning Assembly[88] included a project for hypertension treatment. This work used a system called Simple Telehealth which also makes use of TM[133].

2.4.3 Simple Telehealth

My role as a pharmacist in NHS Sunderland CCG initially highlighted the potential to explore the use of Simple Telehealth for medication adherence. Simple Telehealth is a web-based two-way automated text messaging platform which provides the ability to collect and respond to healthcare information provided by patients. This is achieved through decision-making algorithms which can be personalised to the individual. It is also very flexible, accommodating a wide range of potential response formats including numbers, yes/no and specific key words. It can also combine key words and numbers to collect different types of data from the same patient with the ability to recognise different numbers relating to different readings. Messages can also be one-way.

Messages are organised into text messaging 'protocols' which can be saved for future allocation to patients. Clinicians create their own text messaging protocols and can then incorporate them into their own delivery of care. Training is provided by Simple Telehealth on how to do this, and there are two levels of administrative access; those who set-up the protocols and another where clinicians can access and allocate protocols to patients and personalise them. Personalisation includes the selection of days and times messages are

sent, and protocols can be set up to respond to different values, for example different blood pressure ranges for patients with hypertension and those with renal impairment.

The Simple Telehealth software is procured at the organisational level. Any professional with an account in an organisation with a license can access a patient's data after a patient has provided their mobile phone number to grant access. This creates potential for cross-organisation care to be provided using the same system. A Simple Telehealth community of practice also exists to share materials and text message protocols which are published under creative common licenses.

The automation of the responses using pre-set decision algorithms allows patients to receive an immediate response from the system when they send in readings. Where readings require follow up, for example because they are out of the desired range, the suggested approach is to direct patients to contact their healthcare professional. This reduces the need for clinicians to actively check responses from patients and encourages a level of patient activation.

The original iteration of the Simple Telehealth platform used a persona called 'Florence' or 'Flo' to communicate with patients. Guidance on writing messages for Flo encourages the adoption of a friendly and supportive tone of voice. The use of such 'relational agents' has also been found in smart device apps[134]. The research described here used a newer version of the Simple Telehealth platform providing the opportunity to create more sophisticated protocols. To reflect this change, the persona for the text messaging component of the intervention was changed to 'Alice' and this is reflected in the later studies in this thesis.

2.5 Text messaging in community pharmacy to support medicines-taking behaviour

Combining the known value of community pharmacy to support medication-taking with the potential benefits of TECS was an attractive area for research. Using automated two-way text messaging may offer some synergy to face-to-face consultations and facilitate a more efficient intervention. However, the content needed to specifically target medicines-taking was unclear.

There was also limited evidence for the use of technological interventions delivered from the community pharmacy environment. In 2018, Cork et al.[135] trialled the use of Flo from community pharmacies using text messaging protocols available within the Simple Telehealth community of practice alongside another self-care app. The evaluation numbers were small and focused on pharmacist perceptions of the technology. The findings revealed that time to use the technology was a barrier to uptake, and the relevance of using the technology didn't seem to be clear to participants. How TECS might be delivered from community pharmacies was therefore important to explore.

When asked about the expansion of patient-facing services by pharmacists, research has also found that GPs often express concern, in particular surrounding role duplication and confusion for patients[136]. Research with pharmacists providing extended services has also found lack of clarity about where their role overlaps with that of general practice[76,137]. Therefore, design of any new intervention needed to consider how it would fit in the wider care delivered to the patient.

This chapter has highlighted the problem of medication nonadherence and how considering medication-taking as a behaviour may provide insights to support new interventions to improve this. Examples of how pharmacists are already providing support for medication-

taking have been highlighted and the potential role for technology has been introduced. The remainder of this thesis will describe how I have sought to combine these resources into a new intervention to support medication-taking, with a focus on whether this can be achieved for patients with multiple long-term conditions.

Chapter 3 Research Question, Aims and Objectives

3.1 Research Question

Can an intervention be designed which combines automated two-way text messaging and a community pharmacist consultation, to support medication-taking in patients with multiple long-term conditions?

3.2 Aims and objectives

Aim 1: To identify the factors that create successful automated two-way digital communication interventions which aim to improve patient medication-taking

Objectives

- Conduct a narrative synthesis systematic review of studies using automated two-way digital communication aiming to influence medication-taking behaviour
- Evaluate the impact of intervention delivery on patient and professional acceptability
- Code studies for their inclusion of Behaviour Change Techniques (BCTs) and map these to the BCW
- Analyse outcomes from studies including changes in medication adherence and clinical outcomes
- Use analysis to generate a realist programme theory for how automated two-way digital communication interventions can be used to support medication-taking

Aim 2: To co-design with patients and healthcare professionals in primary care, the concept for a new intervention which combines a community pharmacist consultation and automated two-way text messaging to support medication-taking behaviours

Objectives

- Plan an initial design concept for a new intervention based on the findings of Aim 1
- Create prototypes to communicate the design concept for the new intervention
- Conduct focus groups and use a modified version of nominal group technique to gather and prioritise feedback on the intervention concept
- Analyse feedback to make changes to the intervention design

Aim 3: To co-design with patients and healthcare professionals in primary care, how the newly designed intervention might be delivered in the NHS

Objectives

- Use the intelligence gathered from Aim 2 to create the intervention text message library and delivery model for patients, pharmacy training, and communication prototypes for general practice
- Run a combined simulated pharmacy training event and focus group with modified nominal group technique, to gather and prioritise feedback on pharmacy training
- Analyse feedback to make recommendations for the delivery of future pharmacy training to implement the new intervention
- Conduct focus groups with a modified nominal group technique to gather, prioritise, and analyse feedback on the communication prototypes, to recommend a future strategy for intervention communication between pharmacy and general practice
- Deliver a simulated version of the new intervention with patients
- Conduct modified diary-interviews to assess acceptability, explore potential mechanisms of action and contextual mediators of those mechanisms
- Analyse feedback from patients to re-iterate the realist programme theory for how the new intervention may work to support medication-taking

Chapter 4 Research Methodology

This methodology chapter starts by describing the guidance on how to design complex interventions. This is followed by introductions to realistic evaluation, the Behaviour Change Wheel, and Human Centred Design. The chapter finishes with an overview of how these frameworks have been combined in this programme of research, the research methods used and presents the first iteration of the realist programme theory which acted as the starting point for developing a text messaging intervention delivered by community pharmacies (TIMELY).

4.1 Complex interventions

Complex interventions have been defined by the Medical Research Council (MRC) as "interventions which contain several interacting components"[138]. Additional characteristics which were also considered to add complexity included: targeting multiple or difficult behaviours performed by those receiving or delivering the intervention, the number of organisations or levels involved, an increased number or variability in potential intervention outcomes, and the extent to which the flexibility or tailoring is permitted[138]. The intervention developed as part of this research programme meets many aspects of this definition.

The two interacting components in this intervention were the automated two-way text messaging (Alice) and support from a community pharmacy. Community pharmacy support was expected to be tailored to the needs of the patient. A range of behaviours, including patients' use of medicines and the pharmacy team's delivery of support, required targeting. Whilst the main outcome is medication adherence, this is a surrogate outcome, with improvements in health the goal of the intervention. The role of organisational groups or organisational levels was partially considered in this research programme but still represents a significant challenge to future implementation of the designed intervention due to varying

pharmacy ownership models, such as national multiples having different infrastructure and practices compared to independently owned pharmacies.

4.2 Co-design approaches to complex interventions

Co-design of complex interventions with patients and/or healthcare services has become an area of increasing interest in applied health research. Designing with patients however has methodological issues from potential power imbalances between patients as intervention end users and professional intervention designers[139]. Researchers must find ways to obtain feedback which has a positive impact on the design process and allows end users to feel empowered to provide feedback. It is also important that design processes are good quality to ensure that interventions which are not suitable for adoption are not progressed into expensive evaluation exercises and thus producing research waste[140].

There are a variety of approaches available for developing complex healthcare interventions with or without the involvement of patients and/or healthcare providers. A recent taxonomy of these approaches identified eight categories of approach: Partnership, target population-centred, theory and evidence-based, implementation-based, efficiency-based, stepped or phase-based, intervention-specific, or combination[140]. Efficiency-based approaches use experimental designs to determine active components, and while this would be an option for later in the development of the TIMELY intervention, there were too many unknowns to use this approach immediately. Intervention-specific approaches design where there is a known intervention in mind, for example a digital solution. An example approach would include that created by Abroms et al.[141]. However, as the intention was to design an intervention which would blend digital and non-digital components, this approach would also be less useful.

‘Partnership’ methodologies often use an inductive approach, starting with service users in a particular context or setting to design an intervention with no specific idea about what will be

designed. Due to the large literature base for medication adherence, it did not seem a good use of development time to use such an inductive approach. And because the intervention had already been decided as a text messaging intervention delivered from a community pharmacy setting, the design could not consider other potential interventions. Therefore, this approach was also not appropriate for developing the TIMELY intervention. Instead, a target population-based approach would be used which focuses on involving the people who are intended to use the intervention, specifically Human Centred Design. More information about this approach and why this was chosen can be found in Section 4.5.

Using a 'Theory and evidence-based' approach to complex intervention development places less emphasis on involving end users, and more on using evidence and theory[140]. This is suggested as a way of ensuring that interventions have a reasonable chance of being effective[140]. Potential tools to achieve this include: the MRC Complex Intervention Development Framework, the Behaviour Change Wheel (BCW), Intervention Mapping, Matrix Assisting Practitioner's Intervention Planning Tool (MAP-IT), Normalisation Process Theory (NPT) or the Theoretical Domains Framework (TDF)[140]. Most of these approaches include both drawing from the evidence and simultaneously drawing on theoretical approaches to developing interventions, and I felt both would be important for the present intervention design. This would include using both the MRC Complex Intervention Development Framework[138] (see Section 4.2.1) and the Behaviour Change Wheel (see Section 4.4).

Implementation-based approaches are used to place more focus on how an intervention might be adopted into real-world practice settings[140]. However, this approach assumes that an effective intervention has already been designed and is ready for implementation. As this was not the case here, this type of approach would not be appropriate. However, the HCD approach does encourage implementation considerations, and so they would still be considered as part of the present intervention development approach.

Stepped/ phased intervention development approaches place an emphasis on designing interventions as part of iterative phases based around clear intervention aims and mechanistic models[140]. This iterative approach is mirrored in the HCD framework, but in the present study I chose to draw on realistic evaluation[142] approaches to mechanistic model building and testing rather than those described in the review by O'Cathain et al.[140]. More information about this realistic evaluation approach is provided in Section 4.3.

4.2.1 The MRC Complex Intervention Development Framework

The MRC first published a framework for developing complex interventions in 2000 and suggested a process which mirrored that for medicines' development[143]. This was updated in 2008 and placed greater emphasis on moving between four stages: development, feasibility and piloting, evaluation and implementation[138]. The most recent version of the framework[117] (published in 2021) was informed by a comprehensive literature review on complex intervention development and the results of a consensus study[144]. The framework resulting from these studies is used here to describe the methodology used in this thesis.

The framework as described by O'Cathain et al.[144] includes five guiding principles for complex intervention development: dynamic, iterative, creative, open to change and looking towards evaluation. This is then supplemented by 10 suggested actions which complex intervention designers should consider and the application of these as part of this research programme is described here.

4.2.1.1 Plan the development process

The problem of medication nonadherence is well recognised and discussed in Chapter 2. However, the potential role of two-way automated text messaging to support adherence to medicines was the initial problem this research programme aimed to address. The approach

to intervention development as described in the MRC framework would be that of 'Combination'[144] (pp. 6).

4.2.1.2 Bring together a team

The team which supported this research programme is made up of three supervisors, each with different expertise. Professor Scott Wilkes, who was a practising General Practitioner (GP) and experienced mixed methods and clinical researcher. Professor Felicity Smith who was a qualified pharmacist and experienced mixed methods researcher with an interest in medication adherence and community pharmacy interventions. Professor Jonathan Ling who was a health psychologist and who has experience of developing and evaluating digital healthcare interventions. The supervisory team was supplemented with the support of a steering committee that included three patient participants, the regional community pharmacy representative for the Pharmaceutical Services Negotiating Committee (PSNC), and later a national lead for the PSNC, a GP and Medicines Optimisation Lead from NHS Sunderland Clinical Commissioning Group and the Director from the selected technology supplier, Simple Telehealth.

4.2.1.3 Design and refine the intervention

This research programme used the IDEO.org model of Human Centred Design (HCD) to iteratively design and refine the intervention. A HCD framework is suggested in the MRC guidance as an approach to developing 'target population centred' complex interventions. This approach also emphasises the important role of end users of interventions and incorporates the suggested MRC action of 'involve stakeholders throughout the development process'[144] (pp. 5). This research programme considered patients, community pharmacy and general practice healthcare professionals as stakeholders who were participants in each of the development phases of the intervention. Further information on the HCD approach is provided in Section 4.5.

4.2.1.4 Review published research evidence

A narrative synthesis systematic review is presented in Chapter 5 and provides evidence which forms the basis for the design of the subsequent studies. However, peer-reviewed literature was also reviewed throughout the intervention development to understand and interpret the data collected and provide intelligence to move the design process forward.

4.2.1.5 Draw on existing theories

This research programme predominantly made use of one existing theory to support the design process, and this was the Behaviour Change Wheel (BCW). The BCW is also mentioned as a theory and evidence-based approach in the MRC framework. The BCW was used to examine several behaviours associated with both the use of medicines by patients, and the delivery of the intervention. The BCW is discussed further in Section 4.4.

4.2.1.6 Articulate programme theory

The MRC guidance recommends the use of logic models to make explicit how complex interventions are expected to work. This research programme took this one step further by seeking to develop programme theories drawing on realistic evaluation principles. Realistic evaluation is cited as an approach in the MRC guidance on evaluating complex interventions [145]. Further information about realistic evaluation is presented in Section 4.3. This approach also fulfils another of the suggested actions within the MRC guidance on complex intervention development which is ‘Understand the context’.

4.2.1.7 Undertake primary data collection

As suggested in the MRC guidance, this research programme used a mixed methods approach to primary data collection (see 4.8).

4.2.1.8 Pay attention to future implementation of the intervention in the real world

The combination of the BCW, HCD and realistic evaluation all played a role in ensuring that the intervention development process was grounded in how the intervention might be implemented in the real world. Following each study, the changes for future implementation were considered and this is discussed in Chapter 10.

4.3 Realistic evaluation

The use of logic or programme models is a common feature of many of the complex co-design methodologies[142]. However, these are often focussed on expected mechanisms and outcomes. Research from the pharmacy setting has highlighted how contexts such as intervention setting can have significant impact on what seems to be the same intervention. This was demonstrated in differing outcomes from pharmacy ownership model for the New Medicine Service for example. A key unknown which this research aimed to answer also surrounded how digital health interventions which have been successfully implemented in other settings might be transferred into a different context of a community pharmacy setting. And so, a methodological approach which would account for this contextual complexity was needed, and this led to the selection of a realistic evaluation approach.

Realistic evaluation uses the underpinning philosophy of scientific realism, which was adopted as the ontology for this research. Scientific realism and realistic evaluation have been popularised through the works of Ray Pawson, in particular his book *Realistic Evaluation*[142]. In 2013, the National Institute for Health Research (NIHR) funded projects to develop standards and guidance on the use of realist methods called the RAMASES projects[146]. These projects solidified a place for realistic evaluation within health and social care research. More recently, Luetsch et al. highlighted the potential for realistic evaluation to be a useful model for pharmacy practice research[147].

Realistic evaluation encourages researchers to consider the contexts, mechanisms and outcomes which relate to the intervention under study. It draws from realist ontology which acknowledges that the world contains within it, real elements[148]. The Scientific Realism described by Bhaskar[148] posits that the acquisition of knowledge about the real world requires a combination of scientific observation, imagined theories to explain these observations and that these should be tested using empirical testing. Realistic evaluation draws from this scientific realism approach but concerns itself with theory generation on how complex interventions exert their effects in the real world[142]. There are no pre-defined ideas about how to acquire the knowledge to support the exploration of how complex interventions work, as such scientific realism acts as both an ontological and epistemological framework, rejecting other epistemological labels[142]. However, what is clear within the scientific realist approach is that all data collection and analysis should be in service to developing a deeper understanding of the phenomenon under study. This is achieved by using a 'retroductive' approach where researchers move between inductive and deductive data collection and analysis, theorising and testing relationships between the contexts, mechanisms, and outcomes of interest.

There are pre-defined assumptions about how outcomes, mechanisms and contexts interact which is illustrated in Figure 3. Outcomes from complex intervention are achieved by mechanisms acting upon a baseline state to move to a changed state. The delivery of these mechanism(s) and the resultant outcomes, however, are both mediated by the context(s) in which they are delivered (for a mechanism) and achieved (for the outcome). A particular mechanism can also trigger a range of outcomes, both anticipated and unanticipated. Within a complex intervention it is also likely that there may be multiple mechanisms. The mechanisms of a complex intervention are also likely to be delivered in a range of different contexts. The following sections describe how the concepts of contexts, mechanisms and outcomes have been applied for the questions of interest in this research programme.

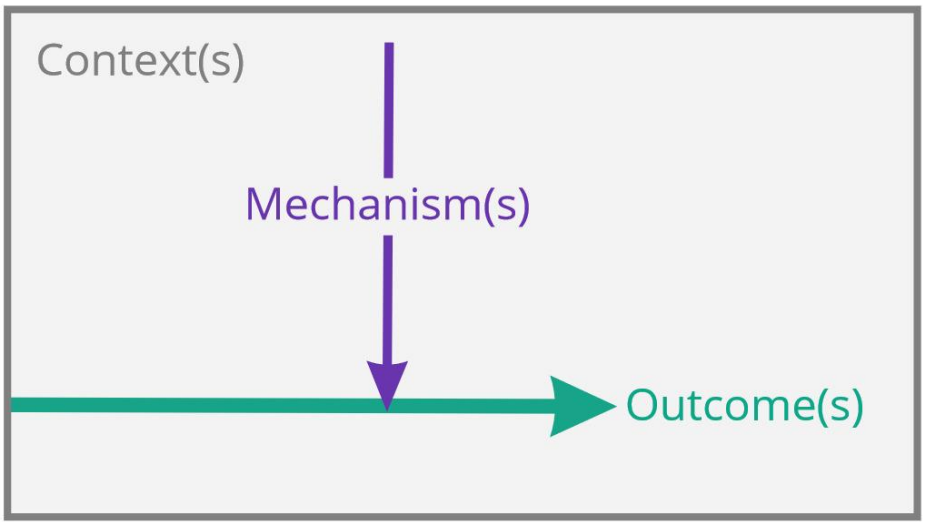


Figure 3 The relationships between mechanism, context and outcomes in scientific realism (Pawson and Tilly, 1997[142])

However, the ultimate aim of a realistic evaluation analysis is to articulate and refine the ways in which each of these constituent parts interact with each other in the form of context-mechanism-outcome configurations[142]. There often many configurations which are generated and defined as part of a complex intervention description. How outcomes, contexts and mechanisms were generally applied in the present research programme is described below and an initial attempt at using these to construct a first iteration of a realist evaluation programme theory for the TIMELY intervention is available in Section 4.7.

4.3.1 Outcomes

The primary outcome considered throughout this research programme is that of medication adherence. However, measurement of medication adherence is known to be difficult. A range of measures exist, using a range of data collection methods[149,150]. From a realistic evaluation perspective, how changes in medication adherence can inform understanding of mechanisms and context is the main concern.

A range of different types of outcomes are also important to understanding the mechanisms. In the case of medication adherence for example, research has already revealed a link between perceptions of medication and that of adherence[34]. Thus, changes to perceptions of medication are also a valuable outcome to measure using tools such as the Beliefs about Medicines Questionnaire (BMQ)[37]. Patterns of outcomes are also important to consider, providing clues about the causality of the mechanisms of interest and the contexts which affect them.

4.3.2 Context

Context has also been identified as important for the success of technological interventions for health[97]. One meta-analysis found that delivery of a text message intervention from a specialist setting such as in secondary or tertiary care was more effective at improving medicines adherence compared to a generalist setting such as general practice or community nursing[112]. In this research programme, the context is community pharmacies in the National Health Service (NHS) in England. This is the setting for all data collection. However, as part of the narrative synthesis in the systematic review (see Chapter 5), this will be expanded to consider delivery of digital communication interventions in high income countries as a similar context to examine a wider pool of evidence.

4.3.3 Mechanisms

The realistic evaluation framework was created within the social sciences domain and describes three types of mechanism; a ‘natural’ mechanism causes the regular patterns of social behaviour, ‘causal’ mechanisms which generate ‘social problems’ and intervention mechanisms those which seek to counter or interfere with these causal mechanisms[142] (pp. 216). However, as this research programme was primarily concerned with individual human behaviours such as taking medication, the intention in this research was to draw on behavioural science principles to describe mechanisms. At the point this work was completed, use of behavioural mechanisms within a realistic evaluation model was relatively

novel. However, there is much overlap in how each discipline defines a mechanism. The BCW framework similarly refers to 'behavioural problems', how COM-B constructs influence behaviours, and how interventions can be designed to alter these influences on individual behaviours (see Section 4.4).

To integrate each of these approaches, the COM-B constructs were considered to be both the 'natural' and 'causal' mechanisms for behavioural performance as each component can act as either a barrier or a facilitator. Therefore, the intervention mechanisms described in this thesis are articulated in how they were found or anticipated to affect behaviours in relation to a COM-B, which could be to remove to reduce a COM-B influence acting as a barrier to behaviour or optimising or enhancing a COM-B influence to increase behavioural performance.

When conducting realist evaluation analyses, it can be difficult to differentiate between mechanisms and contexts due to their close association[151]. Mechanisms have the ability to change contexts, and be triggered by them. It can therefore sometimes be unclear as to whether an outcome is a result of a context or a mechanism. To try and create clearer distinction between these concepts, mechanisms in this research were identified where behaviours changed, or where anticipated to change. Contexts were considered the 'backdrop' for the performance of these behaviours and any changes which were predicted or actually occurred. This approach is similar to subsequent work which integrated behavioural and realist approaches[152,153].

A limitation to using a realistic evaluation approach in this research programme was the limited examples available for integrating this method within a behavioural science project. A realistic evaluation approach can also be very resource intensive. Using the BCW limited some of this by restricting the scope to behavioural mechanisms, though this does mean that

there may be other mechanisms which have not been identified that would have if conducting an analysis using a more sociological approach.

4.4 The Behaviour Change Wheel

Many theories could be adopted as the basis for complex intervention development, with the taxonomy published by O'Cathain et al.[140] specifically mentioning the Behaviour Change Wheel[43], the Theoretical Domains Framework (TDF)[154] and Normalisation Process Theory[155] (NPT). As NPT focusses more on complex intervention adoption, this was not selected as the theory to use as a basis for the present research programme. The TDF has recently been used by other researchers as a theoretical lens within which to explore medication taking as a behaviour[155], however I felt that the categories were restrictive and other authors have found the need to create additional categories to reflect other behavioural influences which do not seem to fit well within the framework[156]. The COM-B model within the BCW however, offers a less detailed framework which seemed to be able to accommodate almost all behavioural influences. Additionally, medication-taking had already been mapped to COM-B[44] and therefore seemed to be a good starting point for the intervention development process in this research programme. Use of the BCW was also facilitated by extensive guidance[157] and in-person training, making it more accessible to me as a non-specialist in health psychology. However, as this was a relatively new framework, examples of its application were limited from which to learn about best practice for its use in complex intervention design.

The Behaviour Change Wheel (BCW) is a process of understanding and then seeking to influence changes in behaviour. The BCW is mapped out in a book authored by a team at University College London[157]. The book sets out a series of steps, each with its own chapter:

- Understand the behaviour[158]

- Identify intervention options[159]
- Identify content and implementation options[160]

The COM-B model as it applies to medication-taking is outlined in Section 2.2.3, although this analysis was further refined in this research by considering a series of inter-linked medication-taking behaviours that will be outlined in the narrative synthesis results described in Chapter 5. The BCW was used to understand the behaviours around interacting with a text message intervention which is outlined in Chapter 7 and how pharmacy teams could be training for intervention delivery behaviours which is described in Chapter 8. Thus, the BCW was used to support understanding of a range of medication-related and intervention-related behaviours.

Understanding a behaviour is the first step in the BCW framework. If the intention is then to influence that behaviour, this starts with the selection of the potential 'intervention functions' which could be used to counteract or promote an aspect of capability, opportunity or motivation affecting that behaviour. This is represented in Figure 4, with the COM-B constructs in the centre of the wheel and behaviour change mechanisms sitting in the outer layers. In this research, the main focus is on the inside ring of intervention functions designed to influence individuals' behaviours directly as opposed to the outer layer of policy categories which suggest strategies for changing behaviours at the population level. The authors of the BCW also provide a table which cross-references each COM-B influence with a suggested intervention function[161] and a suggested list of Behaviour Change Techniques (BCTs) which could be used to deliver that intervention function[162]. Evidence for which BCTs are most effective at delivering these intervention functions, however, is somewhat limited. The narrative synthesis systematic review was used to identify evidence for the links between BCTs, intervention functions and COM-B influences of medication-taking. However, in other points this thesis draws from some of the suggestions in the BCW in absence of other evidence.

The taxonomy of 93 BCTs was published by Michie et al.[50]. There is also accompanying training on how to code these BCTs which I undertook as part of this PhD programme. However, this taxonomy is not without its limitations, especially when applied to the complex series of behaviours linked to medication adherence. It was sometimes difficult to directly link BCTs, intervention functions and COM-B targets. This is because BCTs can potentially deliver multiple intervention functions and target multiple components of COM-B. So, in many cases I have concentrated how the BCT influences the COM-B component directly to describe the barrier or enabler to the behaviour which is intended to be influenced. However, where it is helpful, intervention functions are also discussed.

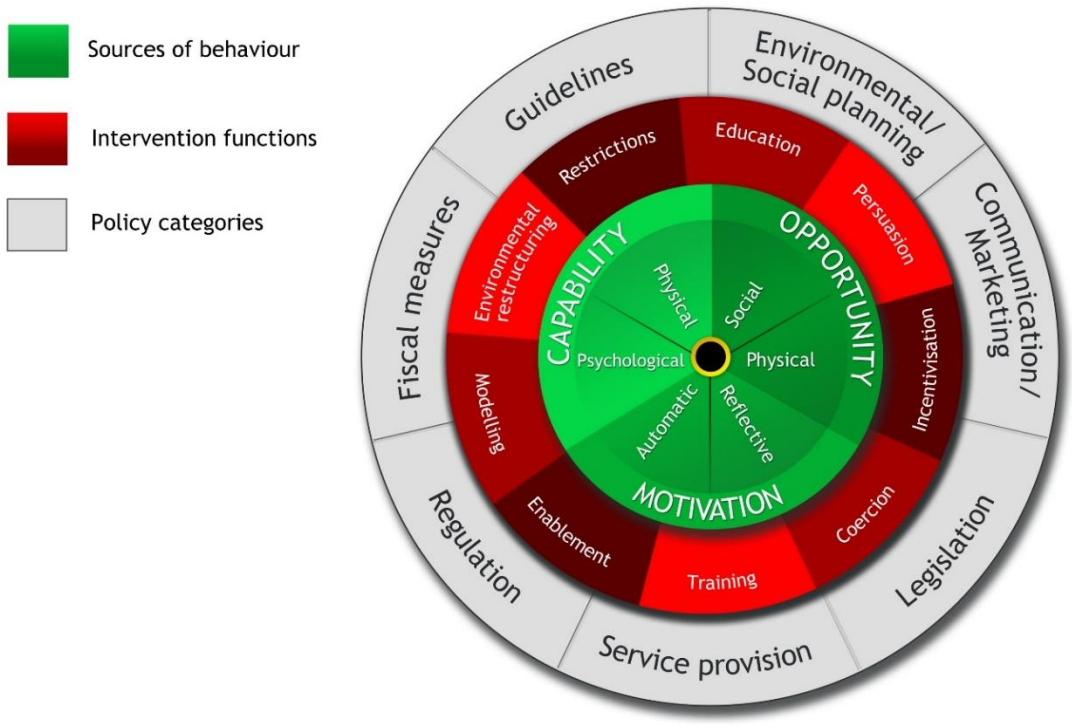


Figure 4 The Behaviour Change Wheel (Michie et al., 2014)

4.5 Human Centred Design

Human Centred Design (HCD) is a target population-based approach to complex intervention co-design, alongside include person-based and user-based approaches[140]. There are overlaps between these, but person-centred places greater emphasis on the psycho-social context of the user. As the present intervention would be designed for a very large and diverse population, this approach seemed to be less relevant.

User-centred design is usually more focussed on organisation design and focuses on what individuals do, rather than what they say they do[140]. This means that it draws more on observation of individuals in a specific setting or context, often in person. These methods would be more difficult to do in the context of patients taking medicines in their own homes as the design scenario for this project. Human-centred design (HCD) draws on many of the similar features present in user-centred design but is used more commonly to design technology[140] and so was the approach selected here. HCD however still has the flexibility to consider non-digital components as it is also used for non-technological design processes.

HCD places the end user as the most important person in the design process and places an emphasis on understanding end user experience[140]. A toolkit and training for using HCD has been developed by IDEO.org[163] but does not provide a development script. It encourages designers to consider their participants and environment to determine the best way to gather feedback for each intervention development. This provided some flexibility for me to pick and choose the tools that I felt would be most helpful to support the development of the TIMELY intervention.

The IDEO model of HCD[163] breaks the design process into three stages: inspiration, ideation, and implementation. Inspiration is the process of gathering information to understand the design problem to be addressed, in particular from the perspectives of the

end user. The ‘ideation’ phase provides tools to develop ideas and identify questions which need to be answered to further support the design process. This stage also suggests the creation of prototypes as a way of gathering feedback from intended users of the design. The final phase is ‘implementation’ where ideas are tested on a small scale using ‘live prototyping’. This acts as a way of testing initial feasibility and acceptability of the design before larger scale delivery.

4.5.1 Applying HCD principles to TIMELY

The IDEO model of HCD guided the data collection and analysis for the studies included in the TIMELY research programme. The ‘inspiration’ phase of the HCD process was achieved using the narrative synthesis systematic review (see Chapter 5). This was then used to create a ‘journey map’ of the TIMELY intervention[163](pp. 90-91). This involved breaking down the intervention design into individual steps. Each step describes an action and how these are sequenced from the beginning to the end of the user’s journey. The journey map for the TIMELY intervention is shown in Figure 5. It was developed using the key components for effectiveness which were identified from the narrative synthesis systematic review and my personal experience as a community pharmacist.

The start of the map is with the patient at home. The patient has multiple long-term conditions, taking multiple medicines and may or may not consider that they are using their medicines optimally. In Step 2, a routine pharmacy visit to collect medication leads to a pharmacy team member asking the patient if they would like support with their medication-taking. This support starts with a face-to-face assessment with the pharmacist shown in Step 3. The pharmacist can pick from a range of solutions including: education, changing the way the medicines are dispensed, providing a multi-compartment aid, paper-based tools or a text messaging intervention. This is represented in Step 4. Where a digital solution is selected, Step 5 shows the pharmacist setting this up and tailoring this. The set-up includes some

provision of information and a consent process. The patient then starts to receive text messages tailored to their needs in Step 6 whilst they self-manage their medicines for their long-term conditions at home. Step 7 shows that as part of the Simple Telehealth text messaging system, patients may be required to reply to messages assessing their health or their medicines-taking. The pharmacy reviews issues resulting from messages in Step 8. Where appropriate, the pharmacy then contacts the patient to provide any additional support (Step 9). The desired outcome is that the patient feels more supported with their medicine taking represented in Step 10.

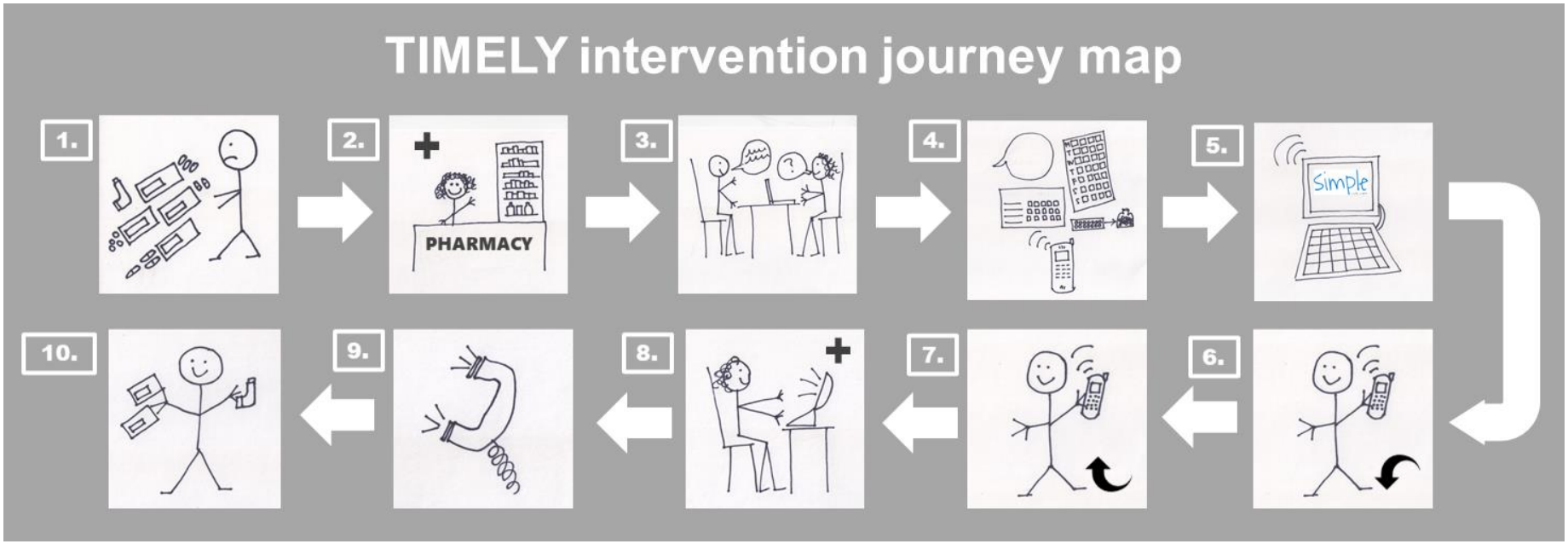


Figure 5 Journey map for the TIMELY intervention

1. Patient having difficulty managing multiple medicines at home
2. Routine visit to community pharmacy to collect medication
3. Face-to-face medication review with pharmacist
4. Selection of most appropriate support for medication-taking
5. If appropriate, patient is set-up to receive text messaging intervention
6. Patient receives text messaging for medication support
7. Patient replies to text messages
8. Pharmacist monitors patient replies to text messages
9. Pharmacist follows up patient via telephone call if needed
10. Patient managing well with multiple medicines at home

4.5.2 Design questions from the experience map

The IDEO HCD model then suggests using the journey map to identify ‘design questions’ which need to be answered to move the design forward. These questions can then be prioritised based on the resources available and the focus of the design project. To support the identification and prioritisation of these design questions, a draft journey map list of design questions was discussed with the steering committee. Table 2 shows the design questions which were considered high priority for answering and in which studies they were examined. As this was an iterative process, multiple studies were used to return to design questions incorporating feedback from previous studies and new questions were added as the design was refined using feedback from participants.

Use of prototypes is a key feature of the HCD process. A prototype is something which is “made” to communicate an idea. The process of creating prototypes also helps designers to think through how their idea might work in the real world. The studies in this research programme made use of a range of prototypes which required an aspect of the intervention design to be fully thought through and communicated to gather feedback from participants as part of the co-design process. Broadly there were two types of prototypes used. ‘Static’ prototypes are the more traditional form of prototype. In this research, they included examples of paperwork, diagrams or videos which are presented to participants. However, in the study of patient delivery and the pharmacy training studies, ‘live’ prototypes were used, where a simulated version of an experience was provided for participants to engage and interact with. The prototypes which were used, how they were created and the data collection methods which were used to gather feedback is described at the start of each study chapter.

Table 2 Journey map design questions cross-referenced with research studies

Journey map step	Design question	Agreed prioritisation with steering committee and rationale	Narrative synthesis systematic review (Chapter 5)	Co-design of concept study (Chapter 6)	Co-design of intervention delivery with patients (Chapter 7)	Co-design of pharmacy training (Chapter 8)	Co-design of comms tools with general practice (Chapter 9)
1.	Which patients do we want to target for the TIMELY intervention?	**Medium:** the narrative synthesis systematic review will highlight which patients may be best for the TIMELY intervention (but this may need to be double checked for the pharmacy setting).	✓	✓	✓	×	×
2.	What is the best way to approach patients for the TIMELY intervention (in a community pharmacy setting)?	**High**: as this is a new setting then this can't be answered any other way.	×	✓	✓	✓	×
2.	Who is the best person to approach them?	**Medium:** need to double check whether this needs to be a pharmacist.	×	✓	×	✓	×
2.	Where in the pharmacy should the patient be approached?	**Low:** experience in other studies/ interventions of approaching patients at the counter or consultation room	×	×	×	×	×
2.	What would encourage patients to find out more about the TIMELY intervention?	**High:** unlikely to be able to be answered elsewhere	×	✓	✓	×	×
2.	How might we offer TIMELY to patients who don't come in to the pharmacy?	**Medium:** target population may not come into the pharmacy so would be helpful to understand how this could be done.	×	✓	×	×	×
3.	How should the TIMELY consultation be structured?	**High:** feedback on this will be key to the delivery of the intervention	×	✓	✓	×	×
3.	How would barriers to medication adherence be assessed?	**High:** acceptability of the assessment tool is key to the intervention	✓	✓	✓	×	×

Journey map step	Design question	Agreed prioritisation with steering committee and rationale	Narrative synthesis systematic review (Chapter 5)	Co-design of concept study (Chapter 6)	Co-design of intervention delivery with patients (Chapter 7)	Co-design of pharmacy training (Chapter 8)	Co-design of comms tools with general practice (Chapter 9)
4.	What other medicines support (in addition to the TIMELY intervention) should be available to the pharmacist to recommend?	**Low:** beyond the remit of the TIMELY intervention and will depend on the professional judgement of the pharmacist and what they have access to provide	×	×	×	×	×
5.	What information will patient need before setting up the TIMELY intervention?	**High:** this will be key for developing the prototyping materials.	×	✓	✓	×	×
5.	What should the information for patients look like?	**Medium:** could use PCPI steering committee members to help with design.	×	✓	✓	×	×
5.	How should the Simple Telehealth protocols be displayed to help the pharmacists choose the right ones?	**Medium:** experience from Simple Telehealth around interface but community pharmacists will be a new setting/user	×	×	×	✓	×
5.	How effective is the TIMELY training (eLearning) at preparing pharmacy teams to deliver the TIMELY intervention?	**ADDED:** Identified following the co-design of intervention concept study	×	×	×	✓	×
5.	Does a self-assessment tool highlight key actions to support introduction of the TIMELY intervention into community pharmacies?	**ADDED:** Identified following the co-design of intervention concept study	×	×	×	✓	×
5.	How effective is the TIMELY pharmacy manual at supporting pharmacy staff to set up patients on the telehealth system and add the correct protocols?	**ADDED:** Identified following the co-design of intervention concept study	×	×	×	✓	×

Journey map step	Design question	Agreed prioritisation with steering committee and rationale	Narrative synthesis systematic review (Chapter 5)	Co-design of concept study (Chapter 6)	Co-design of intervention delivery with patients (Chapter 7)	Co-design of pharmacy training (Chapter 8)	Co-design of comms tools with general practice (Chapter 9)
5.	How should consent be recorded?	**Low:** likely to follow existing protocols for other services/research activities	×	×	×	×	×
5.	What happens if the pharmacist sets up the wrong protocols?	**High:** potential risk of providing wrong information to patients and likely concerns of other HCPs e.g. GPs	×	✓	×	×	×
5.	What information on a notification letter will support appropriate information being added to the patient records for TIMELY patients?	**ADDED:** Identified following the co-design of intervention concept study	×	×	×	×	✓
5.	What information needs to be available on a web-based resource for general practices supporting patients receiving messages from the TIMELY intervention?	**ADDED:** Identified following the co-design of intervention concept study	×	×	×	×	✓
6.	What will encourage patients to read the text messages they receive?	**Medium:** information will be taken from other studies but will require a sense check	×	×	✓	×	×
6.	What should the messages be worded like?	**Low:** information will be taken from other studies, and we have an existing framework in Flo	×	×	×	×	×
6.	How often should the text messages be sent?	**Medium:** information will be taken from other studies but will require a sense check	✓	×	✓	×	×
6.	What information should text messages contain?	**Medium:** information will be taken from other studies but will require a sense check	✓	✓	✓	×	×
6.	When should text messages be sent?	**Low**: this can be tailored to the individual so can't be answered as a general question	×	×	×	×	×

Journey map step	Design question	Agreed prioritisation with steering committee and rationale	Narrative synthesis systematic review (Chapter 5)	Co-design of concept study (Chapter 6)	Co-design of intervention delivery with patients (Chapter 7)	Co-design of pharmacy training (Chapter 8)	Co-design of comms tools with general practice (Chapter 9)
6	Does the personalisation questionnaire successfully make the text message content feel tailored?	**ADDED:** Identified following the co-design of intervention concept study	×	×	✓	×	×
7.	How likely are patients to reply to the messages if asked to do so?	**Low:** can check figures from other studies and this likely won't be answered until a feasibility study	×	×	×	×	×
7.	Which messages should we ask them to respond to?	**Medium:** information will be taken from other studies but will require a sense check	✓	✓	✓	×	×
7.	What information will we ask them to send back?	**Medium**: information will be taken from other studies but will require a sense check	✓	✓	✓	×	×
7.	What should happen if they don't respond to the messages?	**Medium**: information will be taken from other studies but will require a sense check	×	✓	×	×	×
8.	How often will the pharmacy need to check for messages from patients?	**Low: s**hould use a patient activation approach so patients are encouraged to contact the pharmacy with limited active checking required	×	×	×	×	×
8.	How will the pharmacy identify which patients have issues to follow up on?	**Medium:** experience from Simple Telehealth around interface but community pharmacists will be a new setting/user	×	×	×	✓	×
8.	Who in the pharmacy should be responsible for following them up?	**Low:** likely to specific for each individual pharmacy site depending on skill mix	×	×	×	×	×
9.	What outcomes might we expect from a follow up call?	**Low:** Can check figures from other studies and this likely	×	×	×	×	×

Journey map step	Design question	Agreed prioritisation with steering committee and rationale	Narrative synthesis systematic review (Chapter 5)	Co-design of concept study (Chapter 6)	Co-design of intervention delivery with patients (Chapter 7)	Co-design of pharmacy training (Chapter 8)	Co-design of comms tools with general practice (Chapter 9)
		won't be answered until a feasibility study					
9.	What happens if the pharmacy needs to refer the patient to another healthcare professional?	**High:** need to consider how best this can work	×	✓	×	×	✓
10.	Will patients feel more supported as a result of receiving this intervention?	**High**: Need to know this to ensure an effective intervention.	×	×	✓	×	×
10.	How will we measure the success or failure of the intervention?	**Low:** likely won't be answered until a feasibility study	×	×	×	×	×

4.6 A combination approach for complex intervention development

Specific examples of combination approaches were outlines in the review of complex intervention co-design approaches by O'Cathain et al[142] but did not include the specific combination of realistic evaluation, the BCW and HCD. An overview of how these three approaches were brought together as part of this research programme is summarised in Figure 6 alongside the steps of design and data collection. Arrows indicate the order in which these steps were taken, and the boxes indicate how the different approaches were used to execute these steps.

Realistic evaluation principles of articulating and testing the intervention programme theory were used throughout the intervention development process as represented by the purple box. The BCW was used to inform the behavioural content design for medication-taking in both the co-design of intervention concept study (Chapter 6) and the intervention delivery study with patients (Chapter 7). The BCW was also used to example intervention delivery behaviours with patients (also Chapter 7) and pharmacy implementation behaviours in the co-design of intervention training with community pharmacy study (see Chapter 8). The design of the supporting static prototypes and live prototyping models was done using the IDEO.org HCD framework. A range of methods were then used to collect data to evaluate each of these design steps which informed subsequent steps as part of an iterative design process.

This combination is a novel approach, however, includes many of the steps and principles which are common amongst other approaches for co-designing complex interventions. A limitation of this approach was the large amount of design work which was completed without the direct input of end users, instead drawing from the research evidence as a basis for the initial designs. This limited the changes that could reasonably be made to the intervention based on user feedback which would have been more flexible in a partnership

type approach. However, the benefit was that improved the efficiency of the design process though potentially not as much as using efficiency-based co-design approaches. Using HCD also meant that organisational behaviour change, which would also be important for implementation of the intervention, were less well explored than if using a more user-centred design process.

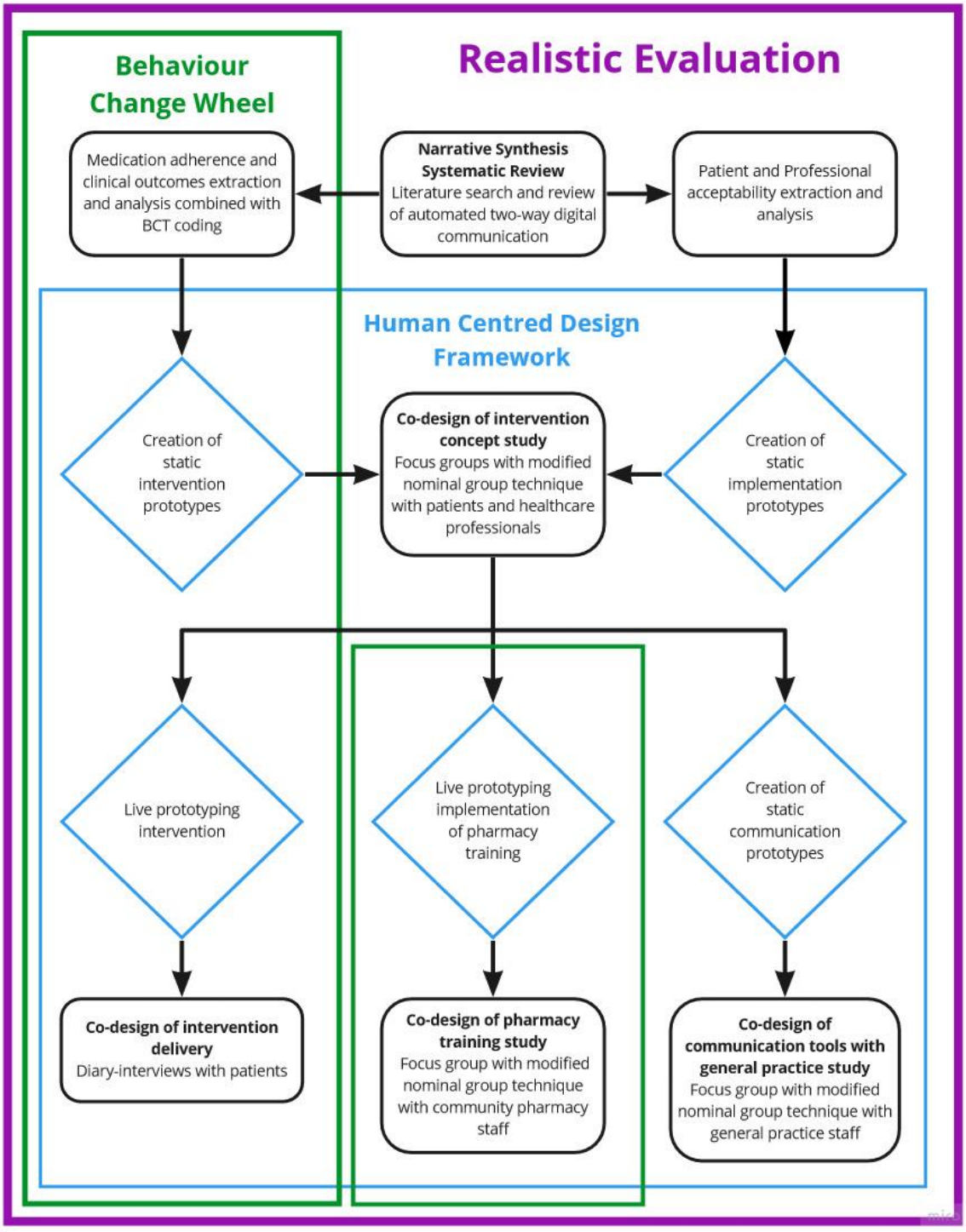


Figure 6 Diagram representing the use of realistic evaluation, the Behaviour Change Wheel and Human Centred Design in the research programme

4.7 First iteration of the TIMELY intervention programme theory

To act as a starting point for intervention development, a first iteration of a realist programme theory for how the TIMELY intervention was expected to work was created and is provided in Figure 7. The aim of this first iteration was to show the hypothesis for how the intervention to be developed was expected to affect the outcome of medication adherence, and the contexts which needed to be examined as potential mediators of these effects. The development of a programme theory or similar logic model formed part of application of realistic evaluation[44] principles and is a common recommendation when developing and evaluating complex interventions[140]. The aim of such a programme theory is to ensure that those involved in the design and evaluation process understand how the intervention is expected to work and to guide the selection of data collection and analysis methods for hypothesis testing.

The first iteration of the programme theory was developed using the background literature review, the work by Jackson et al.[44] mapping medication adherence barriers and facilitators to COM-B, and my experience as a pharmacist. The outcome in the programme theory is medication adherence, which, similar to the representation by Jackson et al.[44], exists on a continuum between sub-optimal and improved medication adherence. This is the outcome from performing of the behaviour 'taking medication' which is represented as the vertical arrow. The COM-B influences on the performance of the taking medication behaviour are highlighted on the left-hand side of the diagram. How each of these COM-B influences could be optimised to support taking medication through the TIMELY intervention are shown on the right-hand side. As with current medication support delivered by community pharmacies, such as NMS and MURs, a medication review with the pharmacist was expected to identify and remove any physical opportunity, physical capability or psychological capability barriers to medication taking. The two-way automated text messaging was anticipated to support the formation of medication taking habits by increasing automatic motivation, and to also

increase reflective motivation towards medication taking through persuasive messaging around the benefits of medication taking.

Potential contexts which the intervention development process would need to examine are also highlighted. The aim was to create a medication-taking intervention which could exist in the patient level context of people living with multiple long-term conditions and polypharmacy. The intervention was also to be designed for delivery in the context of community pharmacies in the NHS. As part of the intervention development and evaluation process, these were the initial starting points for exploration of context alongside development of the intervention components and mechanisms themselves.

The programme theory was iteratively updated following each phase of data collection and analysis. At this point, the medication review framework was a Medicines Use Review, although this later evolved into an ‘enablement’ consultation which will be discussed in later chapters. The two-way automated text messaging component of the intervention started as ‘Florence’, and later would evolve to using the persona ‘Alice’.

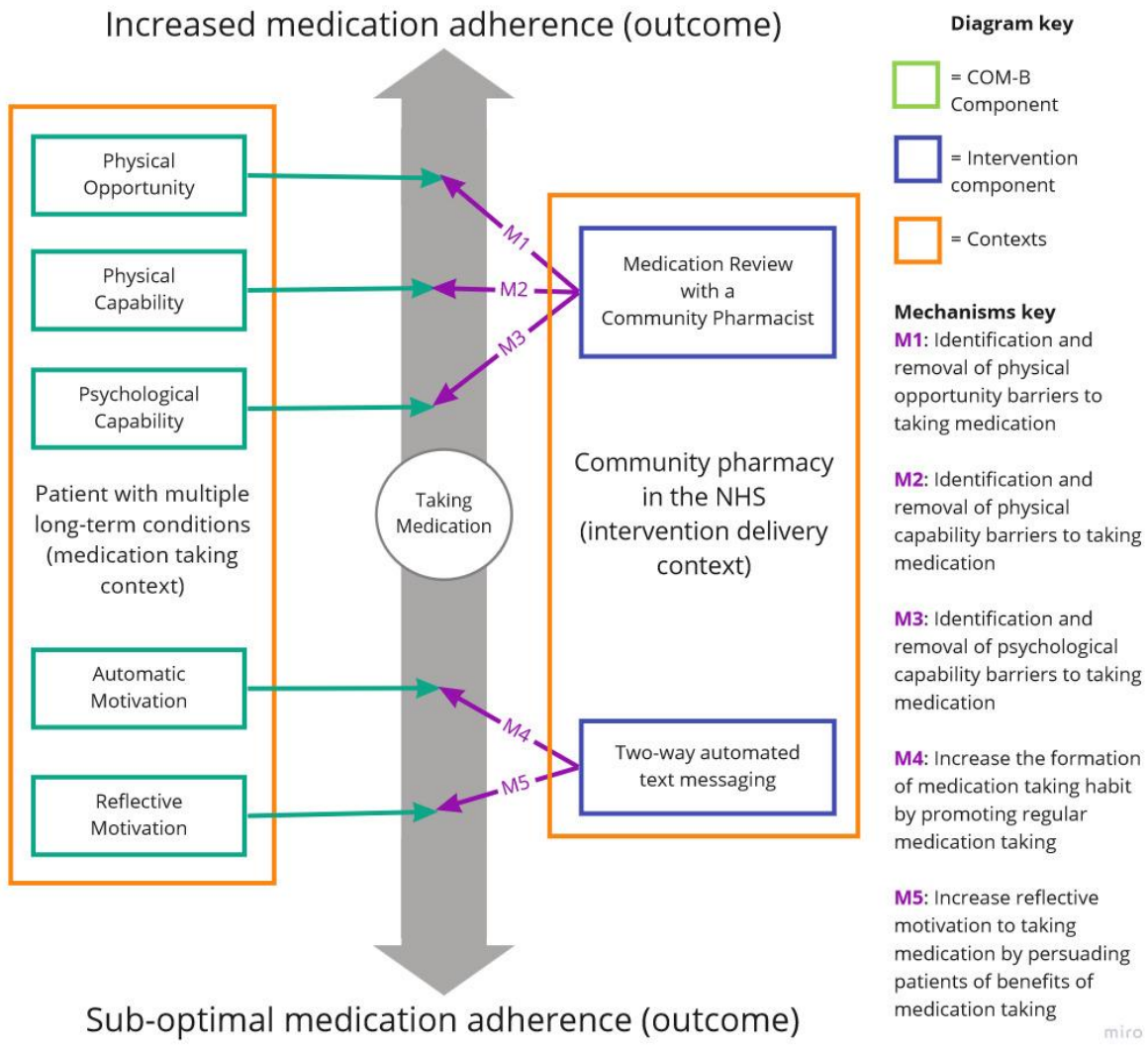


Figure 7 First iteration of a realist programme theory for the TIMELY intervention

4.8 A mixed methods approach

All the frameworks described in this Chapter advocate the use of a mixed methods approach. In particular, the used of mixed methods within the realistic evaluation paradigm enables researchers to see quantitative and qualitative methods as “tools in a toolkit”[164] (pp. 150). The selection of methods and methodological approaches is based on their ability to enable the researcher to achieve their goals. As such, there are no set formulas for what methods should be used and when.

This research programme has used several types of methods within this mixed methods framework including: qualitative focus groups, a modified version of nominal group technique, semi-structured interviews, quantitative data collected through questionnaires and the Simple Telehealth system itself. These data all support the continuous development of the realist programme theory which describes the intervention.

This chapter has described the frameworks which this research has drawn upon to develop, test and evaluate a new intervention combining automated two-way text messaging and support from a community pharmacy. However, descriptions of methods of prototype development, participant selection and recruitment, data collection and analysis are described as part of the subsequent chapters for each of the studies completed as part of the research programme. This includes explanations for why particular methods have been selected and some short discussion on the strengths and limitations of the approaches that were chosen. An overarching discussion of the whole intervention development, alongside comparisons to the development of similar interventions is available in Chapter 10.

Chapter 5 Narrative Synthesis Systematic Review

This chapter describes the narrative synthesis systematic review which was Aim 1 of this research. The aim of the review was to identify the factors that create successful automated two-way digital communication interventions to influence medication-taking. The chapter begins by describing why this review was needed and the gap that the review aimed to fill. How the review question was developed is then explained, followed by details of the search strategy, filtering, and synthesis processes. The results of the review are then presented alongside a short discussion, including a second iteration of a programme theory for the text messaging intervention delivered from community pharmacies (TIMELY) intervention which incorporates the findings from the review.

5.1 Previous reviews of health and digital communication technology

There has been a range of reviews examining digital communication technologies for health. Some of these are focussed on specific clinical conditions including: Human Immunodeficiency Virus (HIV) and/or Acquired Immune Deficiency Syndrome (AIDS)[165,166,175,176,167–174], asthma[177–183], cardiovascular disease[131,184,193,194,185–192], diabetes[195–198], mental health[134,199–205], dermatology[206], cancer care[207], transplantation[208], cystic fibrosis[209], epilepsy[210] and tuberculosis[211]. Some reviews have taken a broader approach, focussing instead on the use of digital communication technologies based on country income[99], geographical area[100,101] or care setting[102]. Some have concentrated on age groups such as the elderly[103–105], younger people[106] or maternal health[212]. Other reviews have been broader still examining a wide range of technology and the use of mobile phones to support individuals' health or health service delivery[89–98].

However, recent meta-analyses have also highlighted the heterogeneity between studies when aggregating results in this area[97,107,112,194,213]. This heterogeneity is likely to be caused by several factors relating to the study population, intervention design and outcome

measures used. Therefore a narrative synthesis systematic review method was used to answer this review question[214] as this uses a qualitative approach to data analysis.

5.2 Developing the review question

A summary of the review questions and considerations of other reviews of Technology Enabled Care Services (TECS) to support medication-taking can be found in Table 3. This analysis helped to identify the issues which this review should consider, including the population, interventions, comparators and outcomes which made up the inclusion and exclusion criteria.

5.2.1 Population

Medicines adherence is a challenge across all age and population groups[215]. This narrative synthesis took an inclusive approach with respect to demographic characteristics and included all long-term conditions among all age groups. However, the focus was on an adult population (over 18 years) to ensure that the intervention was focussed on self-caring individuals rather than children who are likely to have parental or carer support to adhere to their medication regime. Use of mobile technology for health is also increasing especially in high income countries[216]. As the TIMELY intervention was designed for the UK setting, studies from high income countries only were included in this narrative synthesis. This was due to the focus on technological interventions in this setting to improve the patients' self-management[176]. Studies from low and middle income countries were likely to face challenges less relevant to the UK setting including issues such as mobile phone sharing, network reliability, costs of charging and low literacy levels[176]. There was a focus on interventions conducted in English as previous reviews have highlighted the importance of using local language to deliver interventions[100], and the included studies would be used to extract example messages for the future intervention in an English-speaking population in the UK.

Table 3 Summary of literature reviews of Technology Enabled Care Services for medication adherence review questions

Review	Population	Compar-ator	Outcomes of interest	Study types	Study criteria	Delivery consid-ered?	Supplementary components studied?	Synthesis
Linn et al. 2011[109]	Patients taking medication for a chronic condition	None specified	Medication adherence	Quantitative intervention studies	Published in English or Dutch Patient centred only	Yes, tailoring considered	Devices which generate data to send e.g. BGM	Best-evidence synthesis
Hamine et al. 2015[113]	Patients with CVD, diabetes, chronic lung disease	None specified	Adherence to chronic disease management, disease-specific outcomes, usability, feasibility, patient acceptability, healthcare professional acceptability	Qualitative and quantitative intervention studies	Published in English Published 1980-2014	Yes, automation considered	No.	Description and summarisation
Angela-Martinez et al. 2015 [114]	People taking medication for prevention	None specified	Medication adherence, patient acceptability	Quantitative intervention studies and reviews	Published in English or Spanish	Yes, tailoring considered	No	Description and summarisation
Park, Howie-Esquival & Dracup 2014 [115]	People taking medication for prevention	No TM	Medication adherence, patient acceptability, feasibility	All study types (Qual not found)	Published in English	Yes, tailoring considered	Devices which generate data to send e.g. BGM	Message content, description and summarisation
Thakkar et al. 2016 [112]	Adult patients with chronic disease excl. psychiatry	None specified	Medication adherence, patient acceptability	RCTs only	Studies have at least 4 weeks follow up	No	No	Meta-analysis
Wald, Butt and Bestwick 2015 [116]	Adults with HIV, CVD	None specified	Medication adherence	RCTs only	Unclear	No	No	Meta-analysis
Sarabi et al. 2016 [111]	People taking medication for chronic diseases	None specified	Medication adherence, morbidity, mortality, hospitalization, clinical outcomes, patient acceptability	Qualitative and quantitative intervention studies	Published in English	No	No	Description and summarisation
Sarkar, Sivashankar	People taking medication	None specified	Medication adherence	Qualitative and	Unclear	No	No	Description and summarisation

Review	Population	Compar-ator	Outcomes of interest	Study types	Study criteria	Delivery consid-ered?	Supplementary components studied?	Synthesis
and Seshadri 2015 [117]				quantitative intervention studies				
Fenerty et al. 2012 [110]	People taking medication	No intervention	Medication adherence	RCTs only	Published in English At least daily medication	No	No	Average adherence Description and summarisation
Mistry et al. 2015 [118]	People taking medication for a medical condition	None specified	Medication adherence and patient outcomes concurrently	RCTs only	Published in English at least 80% follow up	Yes, automation considered	Yes, devices which generate data to send e.g. BGM	Categorisation, description and summarisation
DeKoekkock et al. 2015 [119]	Adults taking oral prescription medication	None specified	Medication adherence, patient acceptability	Quantitative intervention studies	Published in English Published 2004-2014	Yes, tailoring considered	No	Theoretical basis, message content, implementation, summarisation
Lee et al. 2014 [108]	Adults taking medication	None specified	Medication adherence	RCTs only	Published in English Medication adherence not the primary outcome measure	No	No	Average effect sizes, description
Fang, Maeder and Bjering 2016 [120]	Patients using medication for self-care	None specified	Medication adherence	Unclear	Published 2005-2015	No	No	Descriptive
Tao et al. 2015 [121]	Patients taking medication for chronic diseases	None specified	Medication adherence	RCTs only	Published in English	No	No	Meta-analysis
Granger and Bosworth 2011 [122]	Patients taking cardiovascular medication	None specified	Medication adherence, health service utilisation, health outcomes	Not described	Not described	Yes, automation	No	Description and summarisation
Fjeldscoe, Marshall and Miller 2009 [123]	People receiving behaviour change interventions	None specified	Medication adherence, clinical disease control, process outcomes	Quantitative intervention studies	Published in English	Yes, tailoring	Yes, devices which generate	Categorisation of interactivity,

Review	Population	Compar-ator	Outcomes of interest	Study types	Study criteria	Delivery consid-ered?	Supplementary components studied?	Synthesis
						and initiation	data to send e.g. BGM	description and summarisation
Vervloet et al. 2012 [124]	Patients taking medication for chronic disease	None specified	Medication adherence	RCT and CCTs only	Published in English	No	No	Best-evidence synthesis
Ciciriello et al. 2013 [125]	People exposed to multimedia interventions about medication	No intervention, written information, usual care, information from a HCP	Medication adherence, knowledge about medication, skill acquisition related to medicine, health outcomes, self-efficacy, adverse medication events, compliance with treatment behaviours, patient acceptability, perceptions of illness, beliefs about medication, use of health services	RCTs and quasi-RCTs only	None	Yes	No	Content analysis using the Evaluative Linguistic Framework, meta-analysis, description and summarisation

BGM: Blood Glucose Monitoring; CCT: Controlled Clinical Trial; CVD: Cardiovascular disease EMM: Electronic Medication Monitoring; ERD: Electronic Reminder Device; HCP: Healthcare professional; IVR: Interactive Voice Response; PDA: Personal Digital Assistant; RCT: Randomised Controlled Trial; SMS: Short Message Service; TM: Text messaging

The review included only interventions which are delivered in the community. This would be the setting for the intervention to be developed and consideration of context for technological interventions has previously been identified as important for their success[97,100]. Examining contexts which are similar to the intended intervention would also be important for updating the intervention programme theory. A previous meta-analysis found that delivery of a text message intervention from specialist settings such as those in secondary or tertiary care were more effective at improving medicines adherence compared to a generalist setting such as general practice or community nursing[112], so the potential underlying reasons for this would need to be understood as part of this study.

5.2.2 Interventions

The narrative synthesis focused on research which evaluated interventions with the potential for automation. As the TIMELY intervention would aim to supplement, rather than replace existing care delivery, it was important that the intervention would be cost-effective. A text messaging intervention design requiring large amounts of healthcare professional time, such as telephone consultations or video conferences would be more costly. The UK also faces a shortage of both doctors and nursing staff[217], meaning interventions which are able to minimise the amount to time required to deliver the intervention, whilst maintaining efficacy could be highly attractive. Automation had been considered in some previous reviews (see Table 1) but had not been a focus. Therefore, examination of automation was important to examine in the review

There was a wide variety of potential technology platforms which could be used to deliver an automated communication intervention focussed on medication adherence. Some of these however are limited by their lack of integration within existing healthcare services, poor regulation, high up-front development costs, lack of flexibility and/or the need for more expensive user equipment. To mitigate for some of these limitations, this review focused on the cheapest and most widely accessible technologies already able to accommodate

automation; IVR calls and text messaging using SMS and pagers. Interventions where the primary technology used was smart device applications, email or social media were therefore excluded. These technologies vary in their flexibility, data security, requirement of more sophisticated hardware and cost of set-up. At the time of the funding application for this research, the research funder (National Institute for Health Research) was actively discouraging the development of new smart device applications due to the lack of regulation and high set-up costs. This review therefore focussed on studies of interventions where findings could be transferable to the use of SMS technology using the Simple Telehealth platform.

There was some conflicting evidence surrounding the potential efficacy of one-way versus two-way communication in technological interventions[111,116,118,123,218]. However, why this may be the case was not well understood. How to make best use of the two-way automated communication functionality was therefore something to explore in this review and was an inclusion criterion. Other reviews of technology for medication had highlighted the potential importance of tailoring interventions to address some of the more complex issues around medication adherence (see Table 1). However, how to tailor such content was unclear. This would be further examined as part of the review but would not be an inclusion criterion.

Some of the reviews of digital communication to support medication adherence have concluded that such technologies may be best used to supplement other healthcare services but most reviews did not specifically examine this (see Table 1). Other reviews of text messaging to change health related behaviour also found that interventions with supplementary components had a larger effect on outcomes[219]. Therefore, examining the role of text messages as a complement to existing patient care, rather than as a replacement, was important. This review included interventions where most of the patient contact was conducted through an automated medium, but also included interventions with

supplementary components. This would allow examination of the relationship between digital and non-digital support for medication-taking.

5.2.3 Comparators

All potential study comparators have been included in the review. In particular, a lack of 'active' controls has been highlighted by some reviewers[117] as a potential source for over-estimating the effect of technological interventions. This includes all forms of 'usual care' which is acknowledged will vary depending on the country and context of intervention, as well as any 'active' control groups.

5.2.4 Outcomes

The primary outcome measure used for the review was adherence to medicines aligned to other reviews in this area (see Table 1). All methods for measuring adherence to medicines were included, however those which used more than one method were considered higher quality. Clinical outcomes were also considered in relation to disease control as secondary outcomes, as this should be a further aim of technological interventions following increased medication adherence.

However, a technological communication intervention will not be used unless is it also acceptable for patients. Therefore, a secondary aim of the review was to find studies which evaluated patient acceptability of technological communication interventions. Similarly, one of the challenges associated with the implementation of newer technologies, is the ability of healthcare professionals to incorporate their use into existing clinical workflows[220]. Only one review examined healthcare provider acceptability of digital communication tools for medication adherence[113] however this mainly examined remote monitoring of patients. Wildenbos et al.[220] also highlighted that research into the use of mHealth have frequently neglected to report technical details of how interventions were delivered to patients. Other reviewers have highlighted the lack of reporting on any impact that interventions may have

had on the therapeutic relationship[114]. This narrative synthesis therefore had another secondary objective to examine the acceptability of the interventions to healthcare providers.

5.2.5 Study designs

Many reviews of technological interventions for medication adherence have focussed on quantitative outcomes[109,114,123,124], some using exclusively RCT design[108,112,116,118,121,125] (also see Table 1). Restriction to these study types may prevent incorporation of important translational research[219]. Inclusion of a wider variety of studies may also reduce the risk of publication bias which has been detected in a number of reviews in this area[219]. **I**t was also important to examine results in the context of an intervention being received and then evaluated. For this reason, quantitative results from pilot and feasibility studies, alongside research protocols were excluded.

Randomised controlled trials, quasi-experimental studies, observational studies and qualitative studies were all included as part of the review. There is a potential limitation in including such a wide variety of study types due to the varying degrees of scientific rigour that can be achieved dependant on the study design. This will be countered with the use of study quality appraisal which can be incorporated into the synthesis.

5.2.6 Approach to synthesis

Whilst the overall approach to this review was that of a narrative synthesis, this was supplemented by a behavioural analysis of intervention components using the Behaviour Change Wheel (BCW). Reviews to date have often attempted to separate out the impact of text messaging from within more complex interventions[89,107,112,119] on medication adherence using synthesis techniques such as meta-analysis (see Table 1). The aim of these reviews seems to be to distil a text message intervention into a formulation of content, frequency, and duration of treatment. The complexity of medicines adherence does not lend itself to this distilling, as there may be many reasons why patients may not take their medication (see

Chapter 2). Previous reviews have therefore failed to identify which factors of an intervention contribute to their effectiveness. Additional objectives in this review consisted of coding interventions within the included studies for delivery of Behaviour Change Techniques (BCTs) and map these to the BCW and use this alongside the analysis of study outcomes to update the realist programme theory for the TIMELY intervention.

5.2.7 Review Question

What are the factors that create successful automated two-way digital communication interventions aiming to influence medication-taking behaviour in patients?

5.3 Narrative synthesis systematic review method

The following sections describe the narrative synthesis method which was employed to answer the review question. This includes the search strategy, screening process, data extraction and analysis approaches, including that for considering the behavioural components of interventions studied. The systematic review protocol was also registered on the PROSPERO database (CRD42017069290).

5.3.1 Selection of key words – technological interventions

Until recently, there has been a lack of agreed standardisation in relation to reporting requirements for studies evaluating technological communication interventions to improve health[221]. This has led to a proliferation in terms and abbreviations used to describe the wide variety of communication technologies that have been used as part of strategies to improve health. To formulate a selection of key words to be included in the final search strategy, the methods sections of existing reviews were analysed alongside key words used in primary research publications.

Medical subject headings which were selected for the review include “telephone”, “cell phone”, “smartphone”, “text messaging”, “reminder systems”, “telemedicine”, “mobile health”, “telehealth”, “ehealth” and “mhealth”. PsycINFO subject headings included “telemedicine”, “text messaging”, “cellular phones”, “electronic communication” and “mobile devices”. EBSCO Psychological and behavioural sciences collection thesaurus terms included “text messages (telephone systems)”, “cell phones” and “telecommunication in medicine”. Embase subject headings included “text messaging”, “telemedicine”, “telehealth”, “reminder system” and “mobile phone”. CINAHL subject headings used included “cellular phone”, “telehealth” and “educational technology”.

To capture a wide variety of phraseology describing technological interventions, truncations were used including text messag* or text-messag*. Acronyms and their expanded definitions were also included as part of a strategy for searching abstracts for inclusion in the review including: short message service or SMS, interactive voice response or IVR and technology enabled care service or TECS. To try to capture automated communication with other forms of technology, the following proximity search terms were also included; automat* [within 3 words of] land line or telephone or phone or call.

5.3.2 Selection of key words – medicines adherence

Medical subject headings in this area consist of “medication adherence”, “treatment refusal”, “patient compliance”. PsycINFO subject headings included “treatment compliance”, “prescription drugs” and “drug therapy”. Psychological and behavioural sciences collection thesaurus terms included “patient compliance”. Embase subject headings included “medication compliance” and “treatment refusal”. CINAHL headings included “medication adherence”, “patient compliance”, “compliance with therapeutic regimen”, “noncompliance”, “noncompliance with therapeutic regimen”, “treatment refusal”, “adherence behaviour”, “compliance behaviour”. International pharmaceutical abstracts headings included “compliance”.

To capture further studies examining interventions to improve adherence to medicines, truncations were used combined with proximity search terms; (compliance or adherence or persistence or concordance or nonadherence or noncompliance or non-compliance or nonadherence) [within 5 words of] (Medication$ or medicine$ or prescri* or therap*).

5.3.3 Selection of databases

Publication of articles in relation to medication adherence and use of communication technology were likely to span a large number of disciplines, therefore a range of databases were used to search for potential articles. This included PubMed, Medline, CINAHL, PsychARTICLES, Psychology and Behavioural Sciences collection, Embase, International Pharmaceutical Abstracts, Web of Science and Cochrane Library. Grey literature was also searched including: the Simple Telehealth Network, British Library EthOS, Trove and Opengrey.eu. This was because the grey literature has previously been found to be a source of relevant information in what is a rapidly growing field[176]. Literature reviews which were identified as part of the search also had their reference lists reviewed to identify potential studies for inclusion.

5.3.4 Study screening

To improve the robustness of the systematic review, two reviewers were involved throughout the screening and extraction phases. The second reviewer was Dr Nicola Hall (NH) who was a research fellow for the Pharmaceutical Services Negotiating Committee (PSNC) at the University of Sunderland. Dr Hall is an experienced social science researcher, working on various research projects relating to community pharmacy and was therefore chosen as an appropriate second reviewer as part of the project.

5.3.5 Study selection

Searches of the selected databases were conducted by GD in June 2017. Key words were used to search based on the titles and abstracts of articles. Date limits were applied to only search for studies from 1998 until June 2017. Titles and abstract of initial results list were screened independently by GD and NH to compile a list of articles for full text review. Lists of studies for full text review were compared, with any discrepancies being discussed and agreed. Full text articles were then screened independently by GD and NH and to create a list of studies for inclusion within the review. The screening process was facilitated by Rayyan QCRI [222].

5.3.6 Data extraction

A wide range of data for each study was extracted. This consisted of study characteristics, participant characteristics, intervention characteristics, intervention delivery details and study outcomes. A data extraction form was created using a Google Form[223] (available in Appendix 1). This was piloted with five papers and then revised prior to extraction for all the included papers. Where one study had findings published across several papers, data entry was completed using the relevant papers together to form a single data entry. Data extraction was completed for each study independently by both GD and NH. Discrepancies were resolved through discussion. Study authors were also contacted for further information where data were not available or unclear.

5.3.7 Behaviour change technique coding

BCTs were coded according to the BCT Taxonomy v1[50]. Behaviours associated with medicines-taking were mapped prior to the coding exercise so that the behaviour targeted could also be coded. This map can be found in Figure 8 and shows the medication-taking behaviours which were identified *a priori* by applying the principles of behavioural mapping using guidance from the BCW[158]. To facilitate better aggregation of the data across different studies, medicines and long-term conditions, some behaviours were grouped together. For

example, ordering medication and collecting medication are separate behaviours, but have been grouped under a parent behaviour of 'obtaining' medication. Similarly different routes of medicine administration which would constitute different behaviours (for example inhaling a medicine or swallowing a medicine) have been grouped under 'taking medication'. BCTs were also labelled for whether they formed part of the digital communication component of the intervention, or the wider intervention. Where studies reported intervention characteristics other than within the published findings, these additional sources were used as the basis for the BCT coding. BCT coding was facilitated by use of NVivo 11[224] by coding the BCT, behaviour and delivery mechanism as 'Nodes'.

5.3.8 Study quality appraisal

Due to the wide range of study types included in the review, the Mixed Methods Appraisal Tool (MMAT)[225] was used to appraise the quality of studies included in the review. This was again facilitated by use of a Google Form. Assessment was carried out independently by GD and NH, with discrepancies again resolved through discussion

5.3.9 Data analysis

Summaries of study and intervention characteristics were created using spreadsheets from the data extraction process. The 'Filter' function in Microsoft Excel[226] was initially used to facilitate familiarisation with the data and identify characteristics which seemed to be linked to intervention effectiveness. Vote counting[214](pp.18) was then used to examine these characteristics more systematically against study outcomes. Findings from the vote counting were further interrogated for robustness using study quality appraisal.

For behavioural analysis, coding searches were performed in NVivo 11[224] for where BCT, behaviour and delivery format 'overlapped'. These searches were used to examine the relationships between BCTs, behaviours and delivery formats to generate behavioural component summaries. Analysis of these at the behavioural level was then used to assess

how interventions seemed to influence the different medication-taking behaviours (as shown in Figure 8) . Searches of behavioural components at the study level were also exported as spreadsheets and combined with the extracted data to compare the inclusion of behavioural components with study outcomes, again using a process of vote counting.

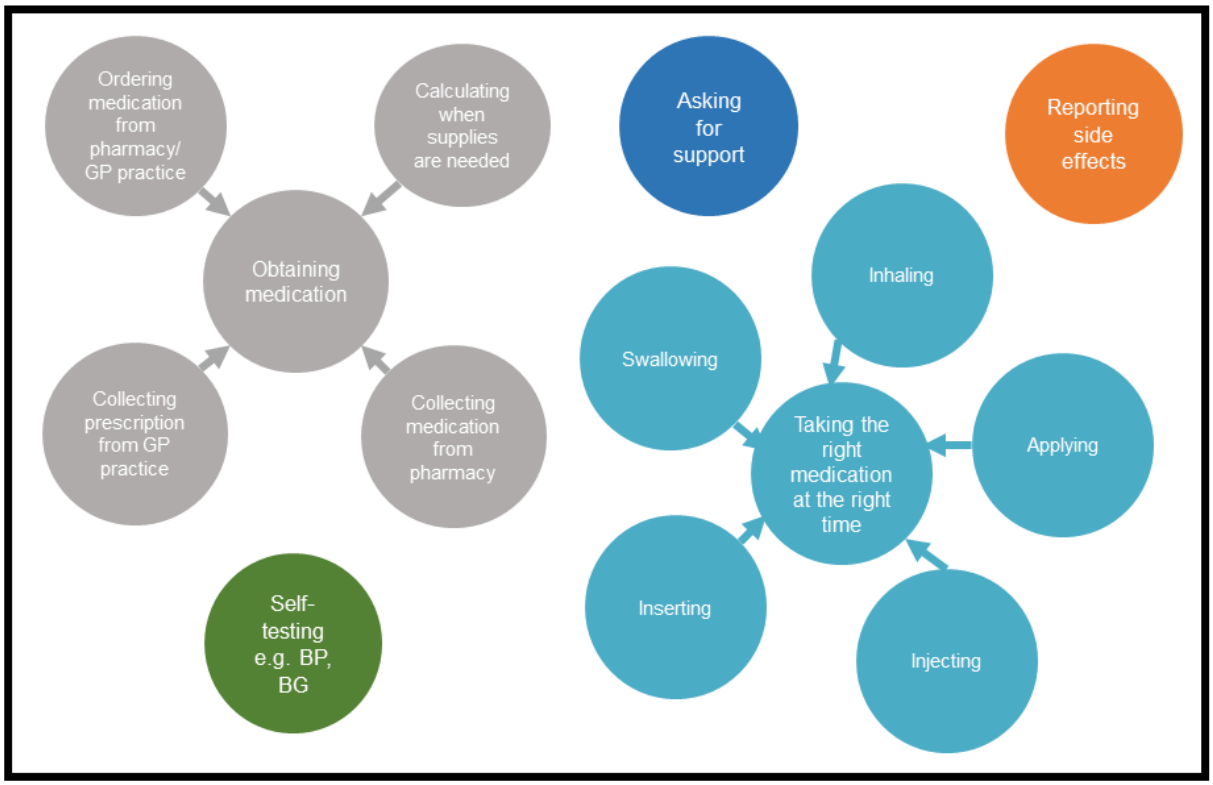


Figure 8 Summary of behaviours determined *a priori* which may be targeted as part of medication adherence interventions

5.4 Narrative synthesis systematic review results

A summary of the screening process can be found in the PRISMA[227] diagram (Figure 9). A total of 4,460 records were identified through database searching. No additional records were found in searches of the grey literature. An additional 25 records were discovered from pearling of references from other systematic reviews and two records were also found from the reference lists of studies identified through the database search. Following removal of 1,442 duplicates, a total of 3018 records were screened using titles and abstracts. This resulted in the exclusion of 2,828 records. 198 were identified for full text review, however the full text could not be retrieved for 43 records, leaving only 155 were ultimately screened.

Following assessment against the eligibility criteria, 43 papers were included in the qualitative synthesis representing 37 different studies. A summary of the included studies can be found in Table 4.

5.4.1 Included studies overview

Most of the studies included in the review were randomised controlled trials (n=25). Other study types included cohort studies, non-randomised controlled trials, one case-control study and one service evaluation. There was also one qualitative study of healthcare professional views on automated two-way digital communication interventions. Most studies had usual care as their comparator. Sample size for patients within the study ranged from 40 to 21,752.

The automated digital communication technologies examined in this review included IVR (n=19), SMS (n=10) and pager devices (n=2). Six studies used a combination of technologies, either to complement each other or to offer patients a choice on which mode of delivery they would prefer. Length of intervention ranged from a one-off call to 12 months. However, most interventions lasted either 3 months or 6 months, suggesting that there might be some consensus that influencing medication adherence requires ongoing communication for at least 3 months. The most common aim for the outcome of an intervention as reported by the study authors was to improve adherence to an existing therapy (n=23) followed by promoting adherence to a new therapy (n=10). A small number of studies included an aim to detect nonadherence to medicines, maintain adherence to medication or prompt changes to medication. In some cases, it wasn't clear what the intended change to adherence was anticipated by the study authors.

Studies were predominantly conducted in the United States (n=30). High income countries also represented within the studies included Canada, New Zealand and the UK.
Most studies delivered interventions to a singular long-term condition. The most common of these was cardiovascular disease (n=15). Other long-term conditions included diabetes,

HIV/ AIDS, depressive disorders, osteoporosis, asthma, chronic obstructive pulmonary disease, glaucoma, and acne.

A summary of the quality appraisal scores can be found in Table 5. Most of the RCTs were good quality, with those on three stars only missing the 'lack of allocation concealment' criteria. Patient concealment is not possible with this type of intervention however those with four stars described concealment of investigators to earn the additional criteria. For the cohort studies and non-randomized controlled trials, lack of clarity around how representative the sample was of the study population was the most common reason for a lower score. One of the quality criteria in the MMAT for qualitative studies is whether appropriate consideration is given to the researchers' influence on the findings, and this element was lacking in all the included studies resulting in lower scores.

Outcomes on patients were extracted for each study on changes to medication adherence and clinical improvement. Where measured, 17 studies reported an increase in medication adherence. Seven found unclear results due to conflicting results between multiple measures used, or where data were not fully reported to make a judgement. Nine studies either found no improvement, or an increase which was not statistically significant.

When comparing study design to outcomes, cohort studies seemed to be more likely to find positive outcomes for trials compared to RCTs. Four of the studies which were mixed methods had inconsistent results in terms of their findings. Most studies used 'usual care' as the comparator, although use of more active controls didn't seem to affect the study outcomes. There did not seem to be a relationship however between sample size and study outcomes. There also did not seem to be any relationship between trial length or time between the end of the intervention and final follow up.

Where clinical outcomes were measured, seven showed an improvement and four found unclear results. Unclear results again were due to conflicting results within the outcome measures used. Nine either found no increase, or an improvement which was not statistically significant. Three studies found improvements in both medication adherence improvement and clinical outcomes, but another six found improvements in medication-taking which did not translate into positive clinical outcomes.

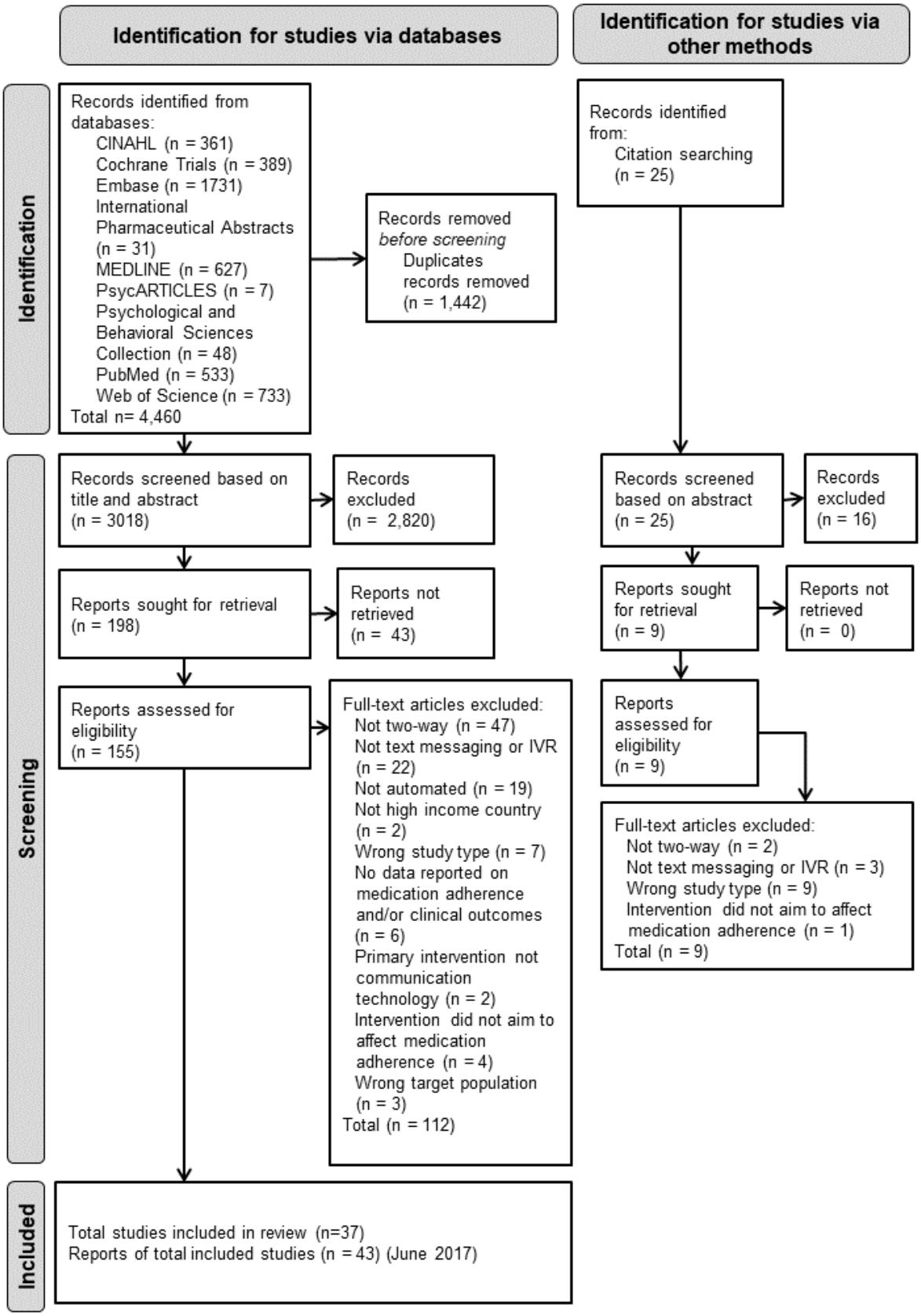


Figure 9 PRISMA diagram for narrative synthesis

Table 4 Summary of studies included in the systematic review

Authors (Date)	Study design	Country	Long-term conditions	Intervention Technology used	Intervention length	Intended medication adherence outcomes for intervention	Comparator (where applicable)	Number of participants
Boker et al. (2012)[228]	Randomised controlled trial	United States	Acne	SMS	12 weeks	Promote medication adherence to a new therapy	TM reminders vs no intervention	40
Bender et al. (2010) [229]	Randomised controlled trial	United States	Asthma	IVR	10 weeks	Improve medication adherence to an established therapy	IVR versus vs no intervention	50
Vollmer et al. (2011) [230]	Randomised controlled trial	United States	Asthma, Chronic Obstructive Pulmonary Disease	IVR	Unclear	Promote medication adherence to a new therapy; Improve medication adherence to an established therapy	Usual care or IVR intervention group	8517
Spoelstra et al. (2016) [231]	Randomised controlled trial	United States	Cancer	SMS	21 days	Promote medication adherence to a new therapy	Intervention group (usual care plus SMS); control group (usual care)	75
Sherrard et al. (2009) [232]	Randomised controlled trial	Canada	Cardiovascular disease	IVR	6 months	Promote medication adherence to a new therapy	Intervention group (IVR follow-up); control group (usual care)	331
Sherrard et al. (2015) [233]	Randomised controlled trial	Canada	Cardiovascular disease	IVR	12 months	Improve medication adherence to an established therapy	IVR vs usual care	1608
Pfaeffli Dale et al. (2015) [234]	Randomised controlled trial	New Zealand	Cardiovascular disease	SMS and supporting website	24 weeks	Unclear	Intervention group (usual care plus mhealth) and control (usual care)	123
Park et al. (2014) [235] and Park et al. (2015) [236]	Randomised controlled trial	United States	Cardiovascular disease	SMS	30 days	Promote medication adherence to a new therapy	TM with reminders + Education; Education TM only; No TM	90

Authors (Date)	Study design	Country	Long-term conditions	Intervention Technology used	Intervention length	Intended medication adherence outcomes for intervention	Comparator (where applicable)	Number of participants
Vollmer et al. (2014) [237]	Randomised controlled trial	United States	Cardiovascular disease	IVR	Unclear	Improve medication adherence to an established therapy	Usual care and an arm with additional educational components including printed materials and a pill box	21752
Stuart et al. (2003) [238]	Randomised controlled trial	United States	Depressive disorders	IVR	3 months	Promote medication adherence to a new therapy	Group 1: Treatment team education and self-care education; Group 2: education and call (1 office nurse call within 2 days of visit); Group 3: Education call and IVR (as group 2 plus IVR program lasting 3 months)	647
Katelenich et al. (2015) [239]	Randomised controlled trial	United States	Diabetes	IVR or SMS depending on patient preference	6 months	Promote medication adherence to a new therapy; Improve medication adherence to an established therapy	Diabetes remote monitoring and management system vs usual care	98
Leu et al. (2005) [240]	Randomised controlled trial	United States	Diabetes	Pager device	3-6 months	Improve medication adherence to an established therapy	pager reminders vs control (usual care)	50
Piette et al. (2000) [241]	Randomised controlled trial	United States	Diabetes	IVR	12 months	Improve medication adherence to an established therapy; To identify potential barriers to medication adherence; To detect medication nonadherence	Intervention group (IVR and nurse telephone follow up); control group (usual care)	280

Authors (Date)	Study design	Country	Long-term conditions	Intervention Technology used	Intervention length	Intended medication adherence outcomes for intervention	Comparator (where applicable)	Number of participants
Boland et al. (2014) [242]	Randomised controlled trial	United States	Glaucoma	IVR or SMS depending on patient preference	3 months	Improve medication adherence to an established therapy	SMS or IVR reminders vs no intervention	70
Glanz et al. (2012) [243]	Randomised controlled trial	United States	Glaucoma	IVR	9 months	Improve medication adherence to an established therapy; To identify potential barriers to medication adherence	IVR and printed materials vs usual care	312
Piette et al. (2015) [244]	Randomised controlled trial	United States	Heart failure	IVR	12 months	Improve medication adherence to an established therapy	One with mHealth alone, one with mHealth+Care Partner	372
Garofalo et al. (2016) [245]	Randomised controlled trial	United States	HIV/ AIDS	SMS	6 months	Improve medication adherence to an established therapy	Baseline education about ART with or without SMS reminders	109
Harris et al. (2010) [246]; Simoni et al. (2010) [247]; Yard et al. (2011) [248]	Randomised controlled trial	United States	HIV/ AIDS	Pager device	3 months	Promote medication adherence to a new therapy	Intervention groups (peer support; pager messaging; both) control (usual care)	224
Moore et al. (2015) [249]	Randomised controlled trial	United States	HIV/ AIDS with co-occurring bipolar disorder	SMS	30 days	Improve medication adherence to an established therapy	Control group is daily mood enquiries only.	58
Bove et al. (2013) [250]	Randomised controlled trial	United States	Hypertension	IVR or web-based	6 months	Improve medication adherence to an established therapy	Web or telephone telemonitoring vs usual care	241
Friedman et al. (1996) [251]	Randomised controlled trial	United States	Hypertension	IVR	6 months	Maintain medication adherence to an established therapy	IVR vs usual care	267

Authors (Date)	Study design	Country	Long-term conditions	Intervention Technology used	Intervention length	Intended medication adherence outcomes for intervention	Comparator (where applicable)	Number of participants
Magid et al. (2011) [252]	Randomised controlled trial	United States	Hypertension	IVR	6 months	Improve medication adherence and/or change medication	Usual care control group	338
Cizmic et al. (2015) [253]	Randomised controlled trial	United States	Osteoporosis	IVR	One-off contact programme	Promote medication adherence to a new therapy	IVR and letter vs no intervention	245
Wald et al. (2014) [254]	Randomised controlled trial	United Kingdom	Patient prescribed BP or lipid lowering medication indicating cardiovascular disease	SMS	6 months	Improve medication adherence to an established therapy	Intervention group (text) vs control (no text)	303
Stacy et al. (2009) [255]	Randomised controlled trial	United States	Prescribed statins indicating cardiovascular disease	IVR	180 days	Improve medication adherence to an established therapy; To identify potential barriers to medication adherence	Non tailored advice from 1 IVR call and print material	497
Aikens et al. (2015a) [256]	Non-randomised controlled trial	United States	Depressive disorders	IVR	6 months	Improve medication adherence to an established therapy	IVR group vs IVR plus support person	221
Aikens et al. (2015b/c) [257,258]	Non-randomised controlled trial	United States	Diabetes	IVR	3 or 6 months	Improve medication adherence to an established therapy	IVR only group vs IVR with Carepartner (peer support)	303
Zabinski et al. (2012) [259]	Cohort study	United States	Cancer, cardiovascular disease, depressive disorders, diabetes, epilepsy, HIV/ AIDS, heart failure,	IVR	One-off intervention	Improve medication adherence to an established therapy; To identify potential barriers to medication adherence	'Control' group from one employer received only medication adherence letters which were sent to all three groups. A second group was made up of people who were	276 (IVR group)

Authors (Date)	Study design	Country	Long-term conditions	Intervention Technology used	Intervention length	Intended medication adherence outcomes for intervention	Comparator (where applicable)	Number of participants
			osteoporosis, hepatitis C				unable to be contacted by IVR or chose not to participate.	
Mayberry et al. (2017) [260]	Cohort study	United States	Diabetes	IVR and SMS	3 months	Improve medication adherence to an established therapy; To identify potential barriers to medication adherence	Not applicable	80
Nundy et al. (2013) [261] and Nundy et al. (2014) [262]	Cohort study	United States	Diabetes	SMS	6 months	Improve medication adherence to an established therapy	Not applicable	74
Shane-McWhorter et al. (2014) [263]	Cohort study	United States	Diabetes, Hypertension	IVR	24 weeks	Improve medication adherence to an established therapy	Not applicable	125
King et al. (2017) [264]	Cohort study	Canada	HIV/ AIDS	SMS	1 year	Improve medication adherence to an established therapy	Not applicable	85
Tucker et al. (2013) [265]	Cohort study	United States	HIV/ AIDS	IVR	70 days	To detect medication nonadherence	Not applicable	44
Auger et al. (2013) [266]	Cohort study	Canada	Prescription medications relating to cardiovascular disease, depressive disorders, diabetes, epilepsy, schizophrenia, inflammatory disorders.	IVR	21 days	Promote medication adherence to a new therapy; To detect medication nonadherence due to potential adverse drug events	Not applicable	200

Authors (Date)	Study design	Country	Long-term conditions	Intervention Technology used	Intervention length	Intended medication adherence outcomes for intervention	Comparator (where applicable)	Number of participants
Nelson et al. (2016a) [267] and Nelson et al. (2016b) [268]	Case-control study	United States	Diabetes	SMS and IVR	3 months	Improve medication adherence to an established therapy; To identify potential barriers to medication adherence	Controls selected based on race, gender and glycaemic control and comparing HbA1c data at 3 months	80
Garg et al. (2016) [269]	Qualitative study	United States	Unclear	SMS	N/A	Unclear	Not applicable	N/A
Cottrell et al. (2015) [270]	Service evaluation	United Kingdom	Asthma, Chronic Obstructive Pulmonary Disease, diabetes, hypertension, chronic pain, chronic kidney disease	SMS	2-3 months (depending on protocol)	Varied according to protocol (multiple included)	Not applicable	3381
AIDS: Acquired Immunodeficiency Syndrome HIV: Human Immunodeficiency Virus; IVR: Interactive Voice Response; SMS: Short Message Service; TM: Text Messaging								

Table 5 Results of study quality appraisal using the Mixed Methods Assessment Tool Version 1

Study	Primary study design	Secondary methods (where applicable)	MMAT Rating	Additional comments from critical appraisal
Bender et al. (2010)	Randomised controlled trial	N/A	****	
Piette et al. (2000)	Randomised controlled trial	N/A	****	
Pfaeffli Dale et al. (2015)	Randomised controlled trial	N/A	****	
Vollmer et al. (2014)	Randomised controlled trial	N/A	****	
Magid et al. (2011)	Randomised controlled trial	N/A	****	Intervention includes medication changes, so prescription issuing as outcome measure likely inaccurate.
Tucker et al. (2013)	Cohort study	N/A	****	
Garofalo et al. (2016)	Randomised controlled trial	N/A	***	
Park et al. (2014) and Park et al. (2015)	Randomised controlled trial	N/A	***	
Leu et al. (2005)	Randomised controlled trial	N/A	***	
Katelenich et al. (2015)	Randomised controlled trial	N/A	***	
Wald et al. (2014)	Randomised controlled trial	N/A	***	28-day medication adherence self-report likely subject to recall bias.
Spoelstra et al. (2016)	Randomised controlled trial	N/A	***	
Bove et al. (2013)	Randomised controlled trial	N/A	***	
Sherrard et al. (2015)	Randomised controlled trial	N/A	***	Medication adherence outcome measure question not provided. Limited description of outcome measure data collection. States intention to treat, but not reflected in described analysis process.
Glanz et al. (2012)	Randomised controlled trial	N/A	***	
Sherrard et al. (2009)	Randomised controlled trial	N/A	***	Medication adherence outcome measure question not provided.
Piette et al. (2015)	Randomised controlled trial	N/A	***	Medication adherence outcome measure unvalidated.
Friedman et al. (1996)	Randomised controlled trial	N/A	***	

Study	Primary study design	Secondary methods (where applicable)	MMAT Rating	Additional comments from critical appraisal
King et al. (2017)	Cohort study	N/A	***	
Mayberry et al. (2017)	Cohort study	N/A	***	
Zabinski et al. (2012)	Cohort study	N/A	***	
Nundy et al. (2014)	Cohort study	Interviews to assess provider acceptability	***	Used a theory informed qualitative analysis for qualitative work.
Nelson et al. (2016)	Case-control study	N/A	***	Medication adherence data only available for intervention 'cases'.
Aikens et al. (2014)	Non-randomised controlled trial	N/A	***	
Aikens et al. (2015)	Non-randomised controlled trial	N/A	***	
Cottrell et al. (2015)	Quantitative descriptive	Qualitative analysis of free-text questionnaire responses	***	Snowball sampling used for questionnaire so unable to determine response rate
Auger et al. (2013)	Quantitative descriptive	N/A	***	
Garg et al. (2016)	Qualitative	N/A	***	
Boker et al. (2012)	Randomised controlled trial	N/A	**	Underpowered study, no sample size calculation provided by study authors.
Harris et al. (2010); Simoni et al. (2010); Yard et al. (2011)	Randomised controlled trial	Focus group and questionnaire assessing patient acceptability	**	Medication adherence in the RCT was calculated using MEMS data from only 7 days leading to review appointment.
Moore et al. (2015)	Randomised controlled trial	N/A	**	
Stacy et al. (2009)	Randomised controlled trial	N/A	**	
Cizmic et al. (2015)	Randomised controlled trial	N/A	**	Study lacks transparency on number of patients included in analysis compared to recruitment.
Vollmer et al. (2011)	Randomised controlled trial	N/A	*	Not clear what the drop-out rate was as sample was "pre-randomised" and figures not provided transparently for those who did not receive the call.

Study	Primary study design	Secondary methods (where applicable)	MMAT Rating	Additional comments from critical appraisal
Shane-McWhorter et al. (2014)	Cohort study	N/A	*	
Boland et al. (2014)	Randomised controlled trial	N/A	*	Underpowered due to lower nonadherence than expected
Stuart et al. (2003)	Randomised controlled trial	N/A	-	No information provided on analysis process, including how cluster randomisation was accounted for. Results are only descriptive.

5.4.2 Findings from behavioural analysis

The behavioural analysis found that medication related behaviours were not well defined within most of the included studies. Although identifying the behaviour targeted by interventions was relatively easy from the descriptions provided by authors, it was never explicitly stated. Four behaviours were found to be the targets of the included interventions including: taking medication (n=34 studies), obtaining medication (n=10), self-testing (n=9) and asking for medication-related support (n=5). 19 studies targeted just one behaviour, 12 targeted two behaviours and five targeted three behaviours. A summary of the BCTs included against their targeted behaviours for both the digital communication intervention and the wider intervention components can be found in Figure 10 and Figure 11 respectively. The targeted behaviour appears in the inner segments, with the specific BCTs appearing in the corresponding outer segments.

5.4.2.1 Mechanism: Increasing reflective motivation for taking medication

Motivation seemed to be the main target for influencing the taking medication behaviour using the digital communication component of interventions, through both the reflective and automatic pathways of the BCW. Targeting the self-testing behaviour was also often linked to influencing reflective motivation. This is aligned to Horne's adapted version of the SRM (see Figure 1) which highlights the role that feedback can have on treatment beliefs in patients. In some studies, self-testing seemed to be designed to increase reflective motivation through improved comprehension of disease and therefore psychological capability. In other studies, it seemed more aligned to monitoring the outcomes of the medication-taking behaviour to influence reflective motivation more directly via the persuasion intervention function.

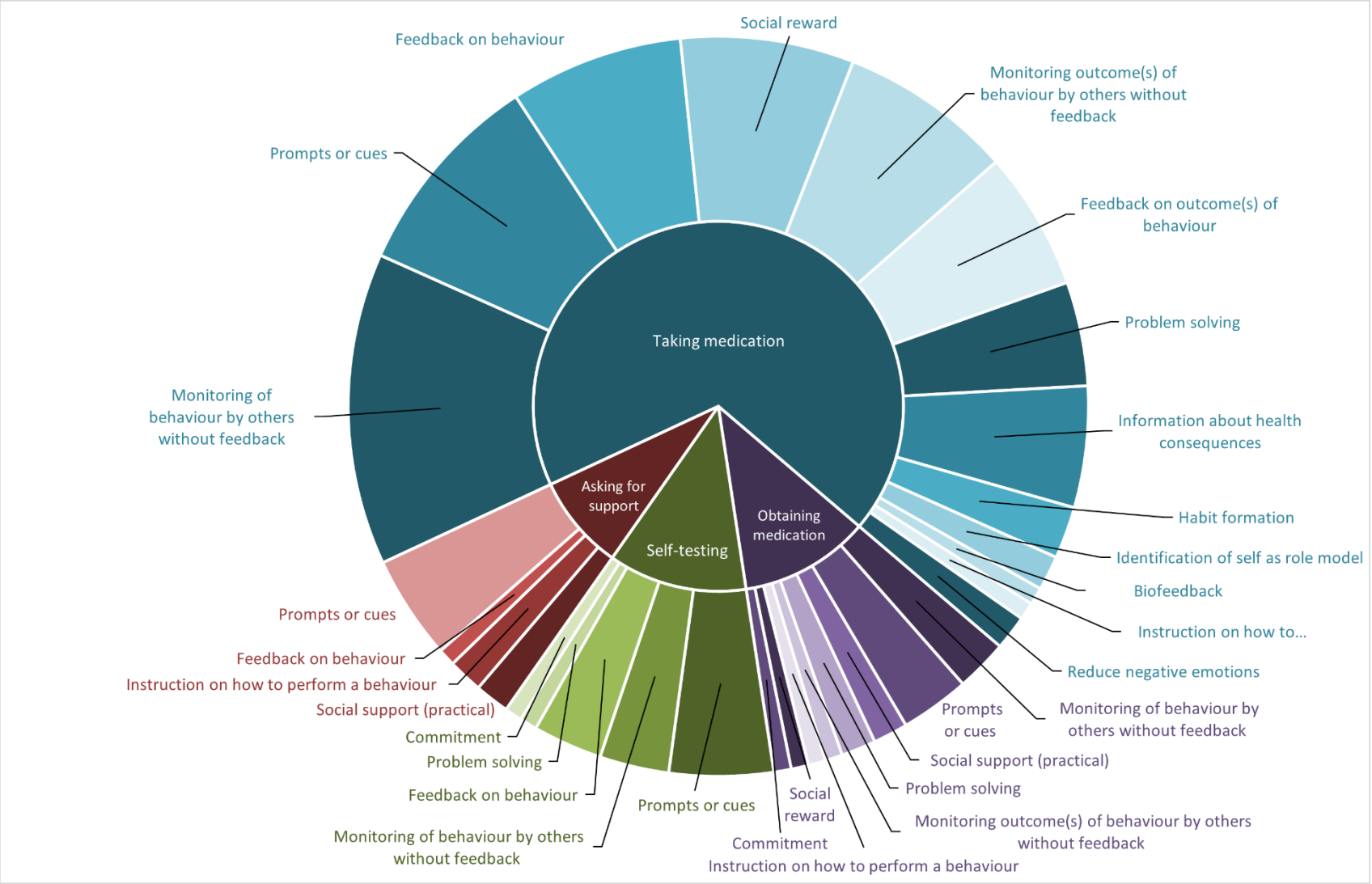


Figure 10 Sunburst diagram displaying proportion of studies using varying behaviour change techniques and their target medication-taking behaviour within automated two-way digital communication components

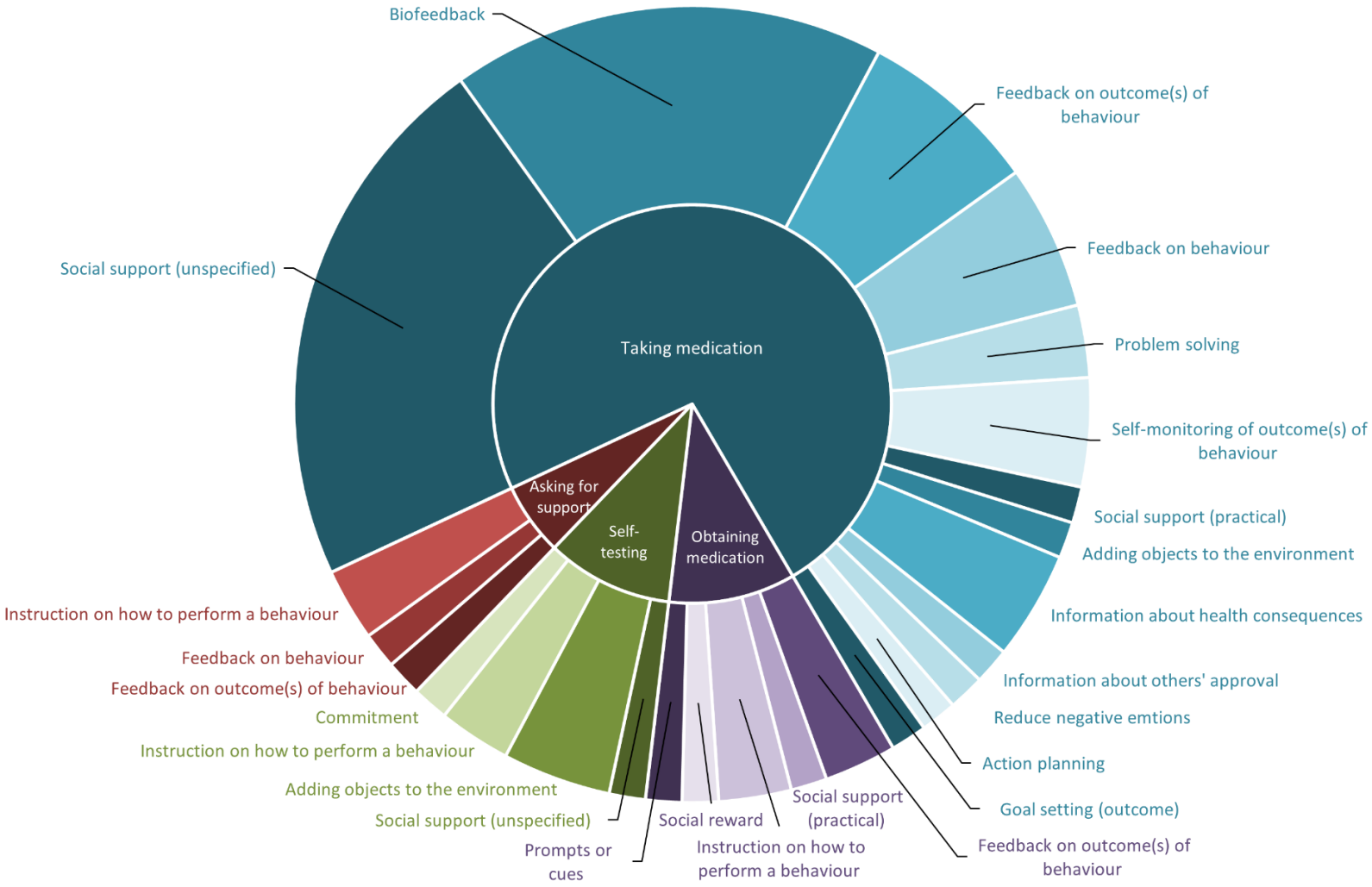


Figure 11 Sunburst diagram displaying proportion of studies using varying behaviour change techniques and their target medication-taking behaviour within wider intervention components

A summary of how studies may be using reflective motivation to influence medication-taking and the clinical outcomes of these studies can be found in Table 6. The BCT 'Biofeedback' is defined as providing feedback about the body using an external monitoring device as part of a behaviour change strategy. This BCT was commonly employed in interventions for hypertension and diabetes. However, feedback was not always provided, with both the BCTs 'Monitoring of the outcome of the behaviour by others without feedback' and 'Feedback on outcomes of the behaviour' both used across the studies. Use of Biofeedback and monitoring BCTs did not necessarily however lead to improvements in medication adherence or clinical outcomes. There were also examples of outcome of medication-taking measured through symptom reporting in depression and asthma, which were coded at the feedback and monitoring BCTs, but could not be coded at the 'Biofeedback' BCT.

To influence an individual's treatment beliefs, the self-testing behaviour itself also needs to occur. In most studies, self-testing was performed in the patients' own home and supported by the provision of equipment as part of the wider intervention (coded as 'Adding objects to the environment' BCT). Some studies however seemed to provide equipment which was not incorporated into the intervention or designed to have a behavioural component to support medicines-taking, for example the inclusion of pedometers. Prompts/ cues and BCTs in the 'monitoring and feedback' category were also used in some studies to specifically target the self-testing behaviour.

An alternative to use of self-testing is to simply provide information on the expected benefits of taking medication. This is achieved through the 'Information about health consequences' BCT. However, its use did not have a consistent effect on medication adherence or clinical outcomes. A BCT which was notably lacking amongst interventions was that of 'Credible source'. Informing patients that medication adherence is important from an authoritative source, could also be used to influence reflective motivation.

5.4.2.2 Mechanism: Increasing habit formation

Habit is included within the automatic motivation pathway for COM-B. A summary of how studies may be using automatic motivation to influence medication-taking and the medication adherence outcomes of these studies can be found in Table 7. The 'Habit formation' BCT is defined as prompting the rehearsal and repetition of the behaviour in the same context repeatedly so that the context elicits the behaviour. Only one study could be coded at this BCT, however, there are a range of other BCTs which it could be argued also supported habit formation included in the digital interventions. The most common was the use of the BCT 'Prompts/ Cues'. For example, a message saying: "It's time to take your medication". However, the inclusion of this BCT did not seem to have a consistent effect on medication adherence outcomes.

In Leventhal's SRM[33], evaluation of performance for a behaviour influences subsequent performance of that behaviour. For medicines-taking, it is difficult to know whether this falls within reflective or automatic motivation. However, BCTs aimed at prompting reflection of that performance were common, such as 'Monitoring of behaviour by others without feedback' and 'Feedback on behaviour'. An example would be a message asking if medication had been taken, for example: "Did you take your medication today?" However, whether this prompted a response from patients or not varied between studies. Three studies used a combination of both prompt and monitoring. In one study, the prompt and monitoring messages were two messages in quick succession[245], in another the same message served both purposes[249]. Two studies used general reminders, one to generally encourage adherence to medicines[243] and another to remind the patient of their blood pressure goal[271], both of which were not able to be coded to specific BCTs. The BCT 'Feedback on behaviour' seemed to have a more positive effect on medication adherence compared to 'Monitoring of behaviour by others without feedback' although the former was more frequently included.

Table 6 Summary of potential influences on medication-taking through reflective motivation and impact on clinical ouctomes

Study	Long-term condition	Adding objects to the environment BCT (self-monitoring)	Biofeedback BCT	Self-monitoring of outcome(s) of behaviour (taking medication) BCT	Monitoring outcome(s) of behaviour (taking medication) by others without feedback BCT	Feedback on outcome(s) of behaviour (taking medication) BCT	Information about health consequences	Self-testing	Clinical outcomes	Clinical Outcome Measure	Clinical outcome summary
Friedman et al. (1996)	Hypertension	No	SM	No	IVR	No	Yes	Blood pressure	Improved	BP	Decreased in mean DBP 5.2 (intervention) vs 0.8 (control) (p=0.02)
Shane-McWhorter et al. (2014)	Diabetes, Hypertension	BP Monitor, weighing scales	SM	No	IVR	No	No	Blood pressure Weight Blood glucose	Improved	BP, HbA1c, Fasting lipids, BMI	Reduction in HbA1c -1.92 (p<0.0001), Reduction in systolic BP -7.8 mmHg (p=0.001) and reduction in LDL -10.2 (p=0.0263)
Katelenich et al. (2015)	Diabetes	No	SM	No	No	No	No	Blood glucose	Improved	HbA1c	Equivalence for controlling HbA1c (8.1% vs 7.9%, p=0.78)
Magid et al. (2011)	Hypertension	No	SM	No	No	IVR	No	Blood pressure	Improved	SBP, DBP	SBP reduction -13.1 mmHg (intervention) vs -7.1 mmHg (control) (p=0.06); DBP -6.5 vs -4.2 (p=0.07)
Mayberry et al. (2017)	Diabetes	No	No	No	No	No	No		Improved	HbA1C	Reduction in HbA1c of 0.22(p<0.07) for participants who completed all adherence assessments.

Study	Long-term condition	Adding objects to the environment BCT (self-monitoring)	Biofeedback BCT	Self-monitoring of outcome(s) of behaviour (taking medication) BCT	Monitoring outcome(s) of behaviour (taking medication) by others without feedback BCT	Feedback on outcome(s) of behaviour (taking medication) BCT	Information about health consequences	Self-testing	Clinical outcomes	Clinical Outcome Measure	Clinical outcome summary
Vollmer et al. (2011)	Asthma, Chronic Obstructive Pulmonary Disease	No	No	No	No	No	No		Improved	Asthma Therapy Assessment Questionnaire	Improvement in percentage of individuals with good control (23% vs 17%, p=<0.007) for those who accessed detailed messages at least twice.
Harris et al. (2010); Simoni et al. (2010); Yard et al. (2011)	HIV/ AIDS	No	No	No	No	No	No		Improved	Viral load and CD4 count	Maintaining CD4 count above 350 cells per millimetre OR 2.20 (CI 1.1-4.42,p=0.0) for intervention vs control.
Leu et al. (2005)	Diabetes	No	SM	No	No	No	No	Blood glucose	Unclear	HbA1C and BP	Decrease in percentage hypertensive patients at follow up compared to baseline (-24%, p=0.013). Neither group achieved the target reduction in HbA1c of 0.5%.
King et al. (2017)	HIV/ AIDS	No	No	No	No	No	No		Unclear	Viral load and CD4 Count	Viral load mean decreased from 1098 copies/mL (baseline) vs 439 copies/mL (end point) (p=0.04). NSS change to CD4 count.

Study	Long-term condition	Adding objects to the environment BCT (self-monitoring)	Biofeedback BCT	Self-monitoring of outcome(s) of behaviour (taking medication) BCT	Monitoring outcome(s) of behaviour (taking medication) by others without feedback BCT	Feedback on outcome(s) of behaviour (taking medication) BCT	Information about health consequences	Self-testing	Clinical outcomes	Clinical Outcome Measure	Clinical outcome summary
Pfaeffli Dale et al. (2015)	Cardiovascular disease	Pedometer	No	No	No	No	No	Pedometer	Unclear	BP, cholesterol, BMI, waist-to-hip ratio	Decrease in total cholesterol intervention group vs control 0.29 (CI 0.61-0.03, p=0.08). No change to BP or HDL/LDL separately.
Vollmer et al. (2014)	Cardiovascular disease	No	WI	No	No	WI	No	Clinic report of blood pressure, lipid levels, HbA1c	Unclear	LDL and SBP	Average 0.5 mmHg reduction in SBP IVR group vs control (p=0.041). NSS differences in LDL for IVR vs UC. Reduction in LDL of 1.5 IVR+ vs control (p=0.019)
Piette et al. (2000)	Diabetes	No	SM	Yes	IVR	No	No	Blood glucose	Not Improved	HbA1c	Adjusted mean reduction in HbA1c in intervention group of 0.3 (CI -0.7 to 0.1, p=0.1)
Bove et al. (2013)	Hypertension	BP Monitor, weighing scales, pedometer	SM	No	No	IVR	No	Blood pressure; Weight; Pedometer	Not Improved	BP, TC, BMI, Fasting Blood Glucose, Triglycerides	Differences between the intervention and control group NSS (no details reported)

Study	Long-term condition	Adding objects to the environment BCT (self-monitoring)	Biofeedback BCT	Self-monitoring of outcome(s) of behaviour (taking medication) BCT	Monitoring outcome(s) of behaviour (taking medication) by others without feedback BCT	Feedback on outcome(s) of behaviour (taking medication) BCT	Information about health consequences	Self-testing	Clinical outcomes	Clinical Outcome Measure	Clinical outcome summary
Aikens et al. (2015a)	Depressive disorders	No	No	No	IVR	IVR and WI*	No	PHQ-9	Not Improved	Depression remission (PHQ-9 score of <5)	Depression remission 8% for IVR group NSS) and to 24% in the IVR + CarePartner group
Bender et al. (2010)	Asthma	No	No	No	No	IVR and WI*	Yes	Asthma symptoms	Not Improved	Asthma Control Test (ACT)	Reduction in average ACT score of -1.120 (intervention) vs -1.840 (control) (p=0.530)
Boker et al. (2012)	Acne	No	No	No	No	No	No		Not Improved	Acne lesion counts, Investigator Global Assessment Scale Score	Average change in IGA score 1.07 (intervention) vs 0.68 (control) (p=0.37)
Garofalo et al. (2016)	HIV/ AIDS	No	No	No	No	No	No		Not Improved	Viral load	Mean difference log viral load 0.04 (-0.39 – 0.47)
Nelson et al. (2016a) and (2016b)	Diabetes	No	No	No	No	No	No		Not Improved	HbA1c	Average change in HbA1c of 0.044 ± 1.252 (intervention) vs -0.291 ± 1.418 (matched controls) p=0.42

Study	Long-term condition	Adding objects to the environment BCT (self-monitoring)	Biofeedback BCT	Self-monitoring of outcome(s) of behaviour (taking medication) BCT	Monitoring outcome(s) of behaviour (taking medication) by others without feedback BCT	Feedback on outcome(s) of behaviour (taking medication) BCT	Information about health consequences	Self-testing	Clinical outcomes	Clinical Outcome Measure	Clinical outcome summary
Spoelstra et al. (2016)	Cancer	No	No	No	No	No	Yes		Not Improved	Symptom Inventory	Intervention group had fewer total number of symptoms (ES=0.09), lower summed symptom severity (ES=0.21), and lower summed symptom interference (ES=0.22) (NSS)
Wald et al. (2014)	Patient prescribed BP or lipid lowering medication	No	No	No	No	No	No		Not Improved	Blood Pressure and cholesterol	SBP 132 mmHg (intervention) vs 137 mmHg (control) (NSS). Total cholesterol 4.2 mmol/L (intervention) vs 4.21 mmol/L (control) (NSS)
Aikens et al. (2015b/c)	Diabetes	No	SM	Yes	IVR	IVR and WI*	No	BP; BG	Not studied	Not studied	Not studied
Cottrell et al. (2015)	Various	BP Monitor	SM	Yes	No	SMS	Yes	Varied according to protocol	Not studied	Not studied	Not studied
Moore et al. (2015)	HIV/ AIDS with co-occurring	No	No	No	SMS	No	Yes	Evaluation of mood	Not studied	Not studied	Not studied

Study	Long-term condition	Adding objects to the environment BCT (self-monitoring)	Biofeedback BCT	Self-monitoring of outcome(s) of behaviour (taking medication) BCT	Monitoring outcome(s) of behaviour (taking medication) by others without feedback BCT	Feedback on outcome(s) of behaviour (taking medication) BCT	Information about health consequences	Self-testing	Clinical outcomes	Clinical Outcome Measure	Clinical outcome summary
	bipolar disorder										
Auger et al. (2013)	Various	No	No	No	IVR	WI	No	Severity of symptoms	Not studied	Not studied	Not studied
Piette et al. (2015)	Heart failure	No	No	No	IVR	No	No	HF Symptoms, weight	Not studied	Not studied	Not studied
Boland et al. (2014)	Glaucoma	No	No	No	No	No	No		Not studied	Not studied	Not studied
Cizmic et al. (2015)	Osteoporosis	No	No	No	No	No	Yes		Not studied	Not studied	Not studied
Garg et al. (2016)	Unclear	No	No	No	No	No	No		Not studied	Not studied	Not studied
Glanz et al. (2012)	Glaucoma	No	No	No	No	No	No		Not studied	Not studied	Not studied
Nundy et al. (2014a) and Nundy et al. (2014b)	Diabetes	No	No	No	No	No	No	Diabetes Self-Care Activities Measure	Not studied	Not studied	Not studied

Study	Long-term condition	Adding objects to the environment BCT (self-monitoring)	Biofeedback BCT	Self-monitoring of outcome(s) of behaviour (taking medication) BCT	Monitoring outcome(s) of behaviour (taking medication) by others without feedback BCT	Feedback on outcome(s) of behaviour (taking medication) BCT	Information about health consequences	Self-testing	Clinical outcomes	Clinical Outcome Measure	Clinical outcome summary
Park et al. (2014) and (2015)	Cardiovascular disease	No	No	No	No	No	No		Not studied	Not studied	Not studied
Sherrard et al. (2009)	Cardiovascular disease	No	No	No	No	No	No		Not studied	Not studied	Not studied
Sherrard et al. (2015)	Cardiovascular disease	No	No	No	No	No	No		Not studied	Not studied	Not studied
Stacy et al. (2009)	Prescribed statins	No	No	No	No	No	No		Not studied	Not studied	Not studied
Stuart et al. (2003)	Depressive disorders	No	No	No	No	No	No		Not studied	Not studied	Not studied
Tucker et al. (2013)	HIV/ AIDS	No	No	No	No	No	No		Not studied	Not studied	Not studied
Zabinski et al. (2012)	Various	No	No	No	No	No	No		Not studied	Not studied	Not studied

BCT: Behaviour Change Technique; BMI: Body Mass Index; BP: Blood Pressure; CD4: Cluster of Differentiation 4; CI: Confidence Interval; DBP: Diastolic Blood Pressure; ES: Effect Size; HbA1c: Glycosylated haemoglobin; IVR: Interactive Voice Response; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein; NSS: Not Statistically Significant; OR: Odds Ratio; SBP: Systolic Blood Pressure; WI: Wider Intervention

Table 7 Summary of potential influences on obtaining medication and taking medication through automatic motivation and impact on medication adherence

Study	Targets obtaining medication	Prompts or cues for taking medication	Monitoring of behaviour by others without feedback	Feedback on behaviour	Social support (unspecified)	Social reward	Problem solving	Habit formation	Medication adherence outcome	Medication adherence outcome measure	Medication adherence result summary
Mayberry et al. (2017)	Yes	No	No	SMS	No	IVR	IVR	No	Improved	Summary of diabetes self-care activities medication subscale	Reductions in medication barriers correlated with improvements in medication adherence, regression coefficient -0.08 (p=<0.001)
Aikens et al. (2015b/c)	Yes	No	IVR	IVR	WI	IVR	IVR	No	Improved	Self-report via IVR, Morisky Medication Adherence Scale	-0.57 in adherence scores in the IVR only group (CI -0.83 to -0.32, p<0.001), however greater effect in arm including a care partner
Stacy et al. (2009)	Yes	No	IVR	No	No	IVR	IVR	IVR	Improved	Possession of prescription	Intervention group had increased 6-month point prevalence for medication possession compared to control (70.4% vs 60.7%, p=0.05)
Nundy et al. (2014a) and Nundy et al. (2014b)	Yes	SMS	SMS	SMS	SMS	SMS	No	No	Improved	Morisky Medication Adherence Scale	Morisky 4-item mean score increased from 2.9 to 3.4 at 6 months (p=0.02)
Bender et al. (2010)	Yes	No	IVR	No	WI	No	No	No	Improved	Electronic tracking device on inhaler	Average doses taken as prescribed 64.5% (treatment group) vs 49.1% (control) p=0.003 and positive correlation with

Study	Targets obtaining medication	Prompts or cues for taking medication	Monitoring of behaviour by others without feedback	Feedback on behaviour	Social support (unspecified)	Social reward	Problem solving	Habit formation	Medication adherence outcome	Medication adherence outcome measure	Medication adherence result summary
											improvement in BMQ scores (r=0.342, p=0.0152)
Cizmic et al. (2015)	Yes	No	No	No	No	No	No	No	Improved	Medication Possession Ratio	For patients collecting medication within 25 days in intervention group compared to control unadjusted OR 2.17 (CI 1.29-3.67)
Sherrard et al. (2009)	Yes	No	IVR	No	No	No	No	No	Improved	Self report via IVR (question unclear)	Relative risk for medication adherence for IVR vs control 0.34 (CI 0.20-0.56, p<0.0001)
Vollmer et al. (2011)	Yes	No	No	No	No	No	No	No	Improved	Medication Possession Ratio	Increased adherence in intervention group compared to control of 0.02 (95% CI 0.001-0.003)
Vollmer et al. (2014)	Yes	No	No	No	No	No	No	No	Improved	Modified Proportion of Days Covered	0.022 increase in mean adherence for statin users (0.011-0.034, p=0.000) and ACE/ARB users 0.016 (0.002-0.029, p=0.022). IVR+ was more effective.
Piette et al. (2000)	No	No	No	SMS	No	IVR	IVR	No	Improved	Medication 'problem' reporting via	Intervention group had decreased medication adherence problems 69% of

Study	Targets obtaining medication	Prompts or cues for taking medication	Monitoring of behaviour by others without feedback	Feedback on behaviour	Social support (unspecified)	Social reward	Problem solving	Habit formation	Medication adherence outcome	Medication adherence outcome measure	Medication adherence result summary
										IVR assessment	patients (baseline) to 48%, p=0.003 (after adjustments)
Zabinski et al. (2012)	No	No	No	No	No	No	IVR	No	Improved	Proportion of Days Covered	For intervention group vs control adjusted OR for adherence 1.448 (CI 1.025-2.046)
Wald et al. (2014)	No	SMS	SMS	No	No	No	WI	No	Improved	Self-report covering the last 28 days	16% reduction in patients discontinuing or non-adherent to medication in intervention group vs control (CI 7% - 24%, p=<0.001)
Garofalo et al. (2016)	No	SMS	No	SMS	No	SMS	No	No	Improved	Visual analogue scale	OR 2.12 (CI 1.01-4.45, p=<0.05) that patients were >90% adherent in intervention group compared to control
Sherrard et al. (2015)	No	No	IVR	SMS	WI	No	No	No	Improved	Self report via IVR (question unclear)	Relative risk for medication adherence for IVR group vs control of 2.18 (CI 1.67-2.86)
Boland et al. (2014)	No	SMS or IVR	No	No	No	No	No	No	Improved	Eye drops placed in a medicines bottle with MEMS cap	Median increase in adherence of 13% (p<0.05)

Study	Targets obtaining medication	Prompts or cues for taking medication	Monitoring of behaviour by others without feedback	Feedback on behaviour	Social support (unspecified)	Social reward	Problem solving	Habit formation	Medication adherence outcome	Medication adherence outcome measure	Medication adherence result summary
Friedman et al. (1996)	No	No	IVR	No	No	No	No	No	Improved	Pill count	Mean antihypertensive medication adherence improved 17.7% (IVR users) vs 11.7% (controls) (p=0.02)
Glanz et al. (2012)	No	No	IVR	No	No	No	No	No	Improved	Self-report for taking medication and medication refills	Self-reported adherence 20% (intervention group) vs 13.5% (control) (not statistically significant)
Katelenich et al. (2015)	No	IVR or SMS	No	No	No	No	No	No	Improved	Morisky Medication Adherence Scale	Percentage of patients with above median adherence 37% vs 28% (baseline) (not a statistically significant compared to control)
King et al. (2017)	No	No	No	No	No	No	No	No	Improved	Self-report or prescription refill (whichever was lowest)	Mean medication adherence increase from 60.3% of doses taken to 62.2% (p<0.001)
Nelson et al. (2016a) and Nelson et al. (2016b)	No	No	No	SMS	No	IVR	IVR	IVR	Unclear	Summary of diabetes self-care activities medications subscale	At 1 month, intervention group medication adherence compared to control adjusted OR 3.88 (CI 1.79, 10.86), at two months 3.76 (CI 1.75-17.44), at 3 months 1.49 (CI 0.66-3.10)

Study	Targets obtaining medication	Prompts or cues for taking medication	Monitoring of behaviour by others without feedback	Feedback on behaviour	Social support (unspecified)	Social reward	Problem solving	Habit formation	Medication adherence outcome	Medication adherence outcome measure	Medication adherence result summary
Moore et al. (2015)	No	SMS	No	SMS	No	SMS	No	No	Unclear	MEMS	iTAB users took antiretroviral medication within 65.7 (SD 76.5) minutes of dosing time vs 120.8 (SD 105.5) (control) p=0.02 though not changes in overall mean adherence.
Park et al. (2014) and Park et al. (2015)	No	SMS	SMS	No	No	No	No	No	Unclear	MEMS	Intervention group increased in percentage of doses taken compared to control (93.7% vs 79.1%, p=0.03) (antiplatelets only, no difference for statins)
Pfaeffli Dale et al. (2015)	No	No	No	No	No	No	No	No	Unclear	Morisky Medication Adherence Scale	Increase in mean Morisky Medication Assessment Score by 0.58 (CI 0.19-0.97, p=0.004) at 3 months but not at 6 months
Piette et al. (2015)	No	No	IVR	No	No	No	No	No	Unclear	Self-report via IVR	mHealth+ Care Partner improved medication adherence of 13.8% at 12 months (p=0.01) compared to control. mHealth only not reported.
Tucker et al. (2013)	No	No	IVR	No	No	No	No	No	Unclear	Self report in the previous 24 hours	Correlation found between IVR use and increased medication adherence

Study	Targets obtaining medication	Prompts or cues for taking medication	Monitoring of behaviour by others without feedback	Feedback on behaviour	Social support (unspecified)	Social reward	Problem solving	Habit formation	Medication adherence outcome	Medication adherence outcome measure	Medication adherence result summary
											(r=0.89, p<0.0001). Unclear if this is causative.
Harris et al. (2010); Simoni et al. (2010); Yard et al. (2011)	No	Pager	Pager	No	No	No	No	No	Unclear	MEMS and Simplified Medication Adherence Questionnaire	Not increase in OR for adherence (MEMS or self-report) but lesser reduction in 100% adherence at 6 months, OR 0.5 (CI 0.24-1.03, p=0.06)
Aikens et al. (2015a)	No	No	IVR	IVR	IVR	IVR	IVR	No	Not improved	Morisky Medication Adherence Scale	OR for IVR group 1.11 (CI 0.99-1.24, p=0.070) compared to 1.31 (CI 1.16-1.47, p=<0.001) for control
Stuart et al. (2003)	No	No	No	IVR	No	IVR	No	No	Not improved	Self report via IVR (question unclear)	No significant differences in medication adherence between groups (full details not reported)
Boker et al. (2012)	No	SMS	SMS	No	No	No	No	No	Not improved	MEMS cap on medication tube	33.9% correct dosing in TM group vs 36.5% in control group (p=0.5)
Bove et al. (2013)	No	No	No	No	WI	No	No	No	Not improved	Medication self-efficacy scale hypertension	Medication adherence score 3.56 (±0.81) in telemedicine group vs 3.59 (± 0.85) in control (p=0.86)
Magid et al. (2011)	No	No	No	No	WI	No	No	No	Not improved	Medication Possession Ratio	Medication possession ratio of intervention group (0.85) vs control (0.84) p= 0.88

Study	Targets obtaining medication	Prompts or cues for taking medication	Monitoring of behaviour by others without feedback	Feedback on behaviour	Social support (unspecified)	Social reward	Problem solving	Habit formation	Medication adherence outcome	Medication adherence outcome measure	Medication adherence result summary
Shane-McWhorter et al. (2014)	No	No	IVR	No	WI	No	No	No	Not improved	Morisky Medication Adherence Scale	Medication adherence score for patients with diabetes (pre) 6.2 vs (post) 6.5 p=0.089. For hypertension (pre) 6.3 vs (post) 6.7 p=0.054.
Spoelstra et al. (2016)	No	SMS	SMS	No	No	No	No	No	Not improved	Self-report covering the last 7 days	Percentage of patients defined as adherent increased 20.7% (intervention) vs 6.1% (control) (not significant)
Auger et al. (2013)	Yes	No	No	No	No	No	No	No	Not studied	Not studied	
Cottrell et al. (2015)	No	SMS	No	No	WI	No	No	No	Not studied	Not studied	
Garg et al. (2016)	No	No	No	No	No	No	No	No	Not studied	Not studied	
Leu et al. (2005)	No	Pager	No	No	No	No	No	No	Not studied	Not studied	

CI: Confidence Interval; IQR: Interquartile Range; IVR: Interactive Voice Response; MEMS: Medication Event Monitoring System; OR: Odds Ratio; SD: Standard Deviation

The Feedback on behaviour BCT seemed to be most effective however when combined with problem solving. The Problem solving BCT is defined as analysing, or prompting the person to analyse, factors influencing the behaviour and generate or select strategies that include overcoming barriers and/or increasing facilitation. This was included in five studies within the digital component of interventions and seemed to have a positive impact on medication adherence outcomes. This was most often achieved using tree algorithms in IVR interventions, allowing content to be delivered conditionally based on responses from the patient. This BCT was also usually combined with the Social reward BCT, where a patient was provided with a positive message associated with reporting 'good' medication adherence. In most cases though, specific barriers which were identified were not described by study authors, so it's unclear what the scope of these may have been.

5.4.2.3 Mechanism: Increasing physical opportunity by targeting 'obtaining medication'

Accessibility of medication has been linked to physical opportunity in relation to medication-taking behaviour[44]. Therefore, targeting the behaviour 'obtaining medication' facilitates access to medicines to engage in medicines-taking. Studies which targeted this behaviour to either inform patients how to get medication supplies or prompted them to order or collect their medication had a universally positive impact on medication adherence (see Table 8). These studies usually made use of the BCT 'Instruction on how to perform the behaviour'. Two studies were also coded for providing the BCT 'Social support – practical' through automated transfer to a pharmacy for supporting the 'obtaining medication' behaviour. Most studies targeting obtaining medication also targeted medicines-taking, however their success at improving medication adherence in this review does suggest that interventions may need to target both obtaining medication as well the medicines-taking behaviour itself to be effective.

5.4.2.4 Mechanism: Encouraging patients to ask for support

Some digital communication interventions directly aimed to influence patients to ask for support related to medicines-taking, and some provided this support based on responses to the digital communication component. Fifteen studies included some component of 'live' communication with a healthcare professional alongside the digital communication component as part of a wider intervention (see Table 8). In most cases, this seemed to improve the likelihood that the study found an improvement in medication adherence. However, the content of these interactions was not well described in the studies.

Where described some of these interactions seemed to seek to influence psychological capability by providing further information about the medicine, others aimed to problem solve medication related barriers. Consultation with a healthcare professional beyond digital communication could provide the opportunity to assess physical capability issues in relation to medicines-taking. However, no studies seemed to include this as part of the wider intervention. This could be due to only two studies including a face-to-face component to the intervention. Although not explicitly stated this would suggest that all patients included in the studies were assumed to be physically capable of self-administering their medication.

Additional communication to support medicines-taking was most often with a nurse (n=6). Nurses usually seemed to be offering general advice and support associated with the long-term condition the intervention was aimed at. In two cases the contact was with a pharmacist to provide clinical management of the patient including alterations to therapy[252,263]. These interactions were coded at the 'Social support (unspecified)' BCT. Two studies examined the effect of incorporating a nominated person into the intervention, with whom data was shared to provide peer support the individual.

Table 8 A summary of wider intervention components and study context

Study	Setting for study delivery	Number of sites	Targets 'Asking for support'	Targets 'Obtaining medication'	Wider intervention components	Integration with patients' usual care team	'Who' was communicating
Aikens et al.[257,258]	Out-patient care	16	Yes	Yes	Telephone calls were initiated based on clinician notifications where patients reported "significant nonadherence" or abnormal clinical measures.	Phone calls were conducted by patients' usual care team	Unclear
Boker et al.[228]	Unclear	Unclear	No	Yes	None	None	Unclear
Glanz et al.[243]	Out-patient care	2	No	Yes	None	None	Unclear
Leu et al.[240]	General practice	9	No	Yes	None	None	Unclear
Tucker et al.[272]	Out-patient care	1	No	Yes	None	None	Unclear
Vollmer et al.[230]	Managed care organisation	2	No	Yes	Telephone call with the pharmacist if patients didn't collect medication	Delivered by patients' usual pharmacy	Unclear
Aikens et al.[256]	General practice	13	No	Yes	Telephone calls were initiated based on clinician notifications where the IVR assessment indicated and elevated suicide risk or were nonadherent to the antidepressant medication.	Phone calls were conducted by patients' usual care team	Unclear
Magid et al.[252]	Out-patient care; Managed care organisation	3 organ-isations (unclear how many sites)	No	Yes	Telephone calls with a pharmacist where responses from the patient indicated issues with medication.	Research pharmacist, but communication to usual care team	Unclear
Bove et al.[250]	General practice	2	No	Yes	Telephone calls with research nurses where absent or abnormal results submitted	None	Unclear
Cottrell et al.[270]	General practice	425	No	Yes	Varied according to protocol	Intervention delivered using care plan agreed	Persona based communication (Flo)

Study	Setting for study delivery	Number of sites	Targets 'Asking for support'	Targets 'Obtaining medication'	Wider intervention components	Integration with patients' usual care team	'Who' was communicating
						with patients' usual care team	
Bender et al.[229]	Out-patient care	1	Yes	No	None	None	Researcher
Boland et al.[242]	Out-patient care	1	Yes	No	None	None	Unclear
Auger et al.[266]	General practice	Unclear (48 physicians)	Yes	No	Telephone calls were undertaken by a pharmacist where follow-up was required	Unclear what the relationship was between the patient and the pharmacist (likely linked to research only)	Researcher
Katelenich et al.[239]	Out-patient care	Unclear	No	No	All patients has a face-to-face diabetes medication review before the intervention	Usual care team had access to patients' responses and emergency safeguard where patient was directly linked to endocrinologist if the readings were outside set parameters.	Unclear
Moore et al.[249]	Academic	1	No	No	Face-to-face medication counselling prior to the intervention	None, education provided by research team	Patient themselves
Piette et al.[244]	Out-patient care	1	No	No	Inclusion of a care partner	Monitoring defined as 'urgent' sent to usual care team	Unclear
Cizmic et al.[253]	General practice	28	No	No	None	Transfer to a mail-order service to obtain medications in the IVR	Unclear
Friedman et al.[251]	Non-health community setting	29	No	No	None	Results shared with patients' usual care team	Unclear

Study	Setting for study delivery	Number of sites	Targets 'Asking for support'	Targets 'Obtaining medication'	Wider intervention components	Integration with patients' usual care team	'Who' was communicating
Garofalo et al.[245]	Academic	1	No	No	None	None	Patient themselves
Mayberry et al.[260]	General practice	1	No	No	None	None	Unclear
Nelson et al.[267,268]	General practice	1	No	No	None	None	Unclear
Park et al.[235,236]	Out-patient care	1	No	No	None	None	Unclear
Pfaeffli Dale et al.[234]	Out-patient care	2	No	No	None	None	Unclear
Spoelstra et al.[231]	Community based care; Out-patient care; pharmacy	6	No	No	None	None	Researcher
Stacy et al.[255]	Managed care organisation	1	No	No	None	None	Unclear
Zabinski et al.[259]	Managed care organisation	3	No	No	None	None	Unclear
Harris et al.[246], Simoni et al.[247] and Yard et al.[248]	Out-patient care	1	No	No	None	None	Unclear
Wald et al.[254]	General practice	7	No	No	Telephone call (unknown caller) where no response to the intervention or nonadherence identified	None	Unclear
Sherrard et al.[233]	Out-patient care	1	No	No	Telephone call with nurse where patients did not engage with intervention or responses highlighted issues for follow-up	Nurses part of usual cardiac care team	Unclear

Study	Setting for study delivery	Number of sites	Targets 'Asking for support'	Targets 'Obtaining medication'	Wider intervention components	Integration with patients' usual care team	'Who' was communicating
Sherrard et al.[232]	Out-patient care	1	No	No	Telephone call with nurse where patients indicated that they had missed doses or taken too much medication	Nurse part of research team, but contacted patients' usual care team if required	Unclear
Vollmer et al.[237]	Managed care organisation	3	No	No	Telephone call with the pharmacist if patients didn't collect medication	Delivered by patients' usual pharmacy	Unclear
King et al.[264]	Out-patient care	1	No	No	Telephone calls by research nurses where no response from patients via the intervention	Research nurses could arrange further follow up with local care team	Unclear
Stuart et al.[238]	General practice	30	No	No	Telephone calls from physician when no patient system interaction in 2 days	Delivered by patients' usual care team	Unclear
Shane-McWhorter et al.[263]	General practice; Out-patient care	7	No	No	Telephone calls with a remote care co-ordinator (mostly pharmacists) where reports from intervention suggested follow-up was required	Remote care coordinator part of research team, but contact patients' usual care team if required	Unclear
Nundy et al.[261,262]	General practice	1	No	No	Telephone calls with nurses where responses to intervention were outside pre-defined parameters	Reports sent to usual care team for face-to-face reviews. Unclear if nurses were usual care team.	Unclear
Piette et al.[241]	General practice	2	No	No	Telephone calls with nurses prioritising patients reporting difficulties with medicines-taking via the intervention.	Nurse part of research team, but contacted patients' usual care team if required	Unclear

5.4.2.5 Context: Intervention setting

Realistic evaluation highlights that context is an important factor affecting whether intervention mechanisms are 'triggered' (or not)[142]. The setting of an intervention for example will influence the extent to which an intervention can target multiple behaviours associated with medication-taking, for example, obtaining medication and patients asking for support with medicines. A summary of the contextual factors for interventions examined in this review can be found in Table 8. The healthcare professional and patient relationship has also been suggested as a physical opportunity issue[44] in relation to medicines-taking.

Most studies took place in an out-patient setting (n=13) followed by general practice (n=12). Studies conducted from an out-patient setting only, mostly found positive effects on medication adherence, but not necessarily improvements in clinical outcomes. Results from studies in general practice settings had mixed findings for medication adherence and clinical outcomes. These differences are likely to reflect the different populations between secondary and primary care. Primary care is known to be a more difficult setting in which to demonstrate intervention effectiveness due to the highly pragmatic nature of studies conducted in this setting[273]. It could also be that initiating a digital communication intervention from an out-patient setting also includes the BCT 'Credible source' due to its link to clinical specialists, although this wasn't able to be coded.

Some studies in the United States used a managed care organisation, which delivers several aspects of care. All studies from the managed care organisation setting found positive results on medication adherence and clinical improvement where measured. It is unclear if this may be due to the way that care is organised in the United States, or how this relates to healthcare payment. A small number of studies also used non-health community settings for intervention recruitment including a "senior centre" which seemed to describe a day centre for older people, and a not-for-profit organisation. The study which achieved

positive outcomes across all patient outcomes was actually conducted from the senior centre[251].

The setting may also be directly linked to who and how digital communication is delivered. In most studies, it was the intervention delivery team who initiated the communication (n=25). In a small number of cases, it was expected that the patient would trigger the intervention. Six studies consisted of a mixture of either patient or delivery team initiation either as a way of following up patients who didn't initiate contact as expected or as a way of patients following up in between automated communication.

Studies which used three or less sites generally reported more positive results for medication adherence than those with a larger number of sites delivering the intervention. It was not possible to determine if this is due to the intervention itself or how the research itself was organised in these studies.

5.4.2.6 Context: Professional acceptability of interventions

The success of interventions is also likely to be affected by the extent to which professionals operating within the settings for digital communication interventions find delivery of these acceptable as a contextual factor for mechanism 'firing'. Five studies evaluated professional acceptability. For Garg et al[269], this was the only focus of their research, conducting qualitative interviews on professional opinions of the intervention. Another study also conducted interviews and questionnaires with professionals receiving clinical reports of data from the intervention to support patient care[262,274]. Three others used questionnaires to collect acceptability data from clinicians.

Some studies used digital communication to gather information which was then subsequently used to support clinical decision making. Work done by Nundy et al[262,274] found

that only 3 out of the 12 surveyed clinicians said that the clinical report from the intervention had influenced their care decisions. However, in the work by Stuart et al.[238] 90% said that they had found it helpful and half reported that they felt it improved their delivery of patient care. Of those surveyed in the work by Friedman et al.[251], 85% said that they read the reports and 84% added the information to the patients' medical records. Cottrell et al.[270] asked about usability of their system, finding that 68.4% felt that it was easy to use. However, there was scepticism on how reliable the information provided by patients was.

There was, however, consensus amongst the feedback from healthcare professionals that the data from interventions was useful to support conversations with patients, particularly around self-care. Friedman et al.[251] found that 40% of physicians had used the data from the intervention as part of their consultations with patients and this was echoed by participants in the study by Nundy et al.[261,262] However, for the most part it was unclear in the studies how digital communication interventions could support (or not) therapeutic relationships.

One factor which could effect intervention delivery from a particular setting is 'who' is communicating with the patient via the digital communication. In most of the other included studies it was unclear 'who' was communicating with the patient via the digital component. The TIMELY intervention included the use of a persona to facilitate the digital communication with the patient, aligned to Simple Telehealth's philosophy and their use of 'Florence'. This review only identified one study which had evaluated the use of Florence specifically, but this did not measure medicines adherence. Therefore, the potential impact of using a 'persona' was not able to be evaluated from the included studies.

5.4.2.7 Context: Patient acceptability

A digital communication intervention is only likely to work in the context of it being acceptable to the patient as they require patients to engage to exert their mechanisms of action. A summary of intervention delivery characteristics and patient acceptability outcomes can be found in Table 9. The most common method of evaluating patient acceptability within included studies was a questionnaire, although some studies also used either participant retention or engagement in the study. Engagement was often calculated by examining response rate to text messages requiring a reply, or number of calls completed for IVR interventions. Where results found more than 75% of patients either engaging with the intervention or reporting satisfaction, these studies were categorized as 'positive'. Those with less than 50% were labelled as 'negative' and those in between were identified as 'neutral'.

The interventions evaluated seem to be acceptable to patients in a wide variety of age groups. The mean age of participants across the studies ranged from 22.6 to 76 years old. The average age for the studies was generally reflective of the ages for the long-term condition under study. Younger cohorts were seen in studies of acne, HIV/AIDS and asthma. Older cohorts were seen in studies targeting patients with heart failure, glaucoma and osteoporosis. The study by Vollmer et al.[230] had the widest potential inclusion age range from 18 to 98 years.

Another element which could affect patient acceptability is the frequency of communication. This varied widely amongst the interventions compared in this review. Those with less frequent communication, monthly or even one-off events generally found more positive outcomes on medication adherence than those with more frequent communication, but patient acceptability was found for a range of communication timings. The frequency of communication also varied depending on the BCTs that were delivered, with those studies including prompts/cues for example have a higher frequency of communication. One way to

ensure that communication frequency is acceptable to the patient, could be to personalise or tailor the communication to patient needs.

Personalisation of the intervention was defined as adapting the content of the intervention to the individual and tailoring was identified where the delivered content was changed based on perceived identifiable needs. Where patients were given choices about the intervention delivery was also highlighted. The most common form of personalisation was providing a choice to participants as to when the digital communication took place (n=11) or timing messages according to the prescribed dosing schedule (n=7). Six studies used the name of the participant in the messages, five referenced the medication the patient was taking, and one used the name of their prescriber. In three studies the participants designed the message that they were due to receive themselves, so they were effectively communicating to their future-self. This personalisation of the intervention however did not seem to affect whether an intervention was effective. Patient choice seemed to be associated with a more positive experience of the intervention, though as most studies reported high patient acceptability it is difficult to draw definitive conclusions.

Table 9 A summary of participant and intervention delivery characteristics with a summary of patient acceptability outcomes

Study	Age Mean (SD)	Female (%)	Contact initiated by	Frequency of contact	Targeting	Personalisation	Tailoring	Patient acceptability	Patient acceptability assessed?	Patient acceptability summary
Friedman et al. (1996)	76 (Not given)	77	Patient	Weekly	Patients with uncontrolled hypertension	Unclear	Unclear	Positive	Questionnaire	69% of users scored the intervention positively
Nundy et al. (2014a) and Nundy et al. (2014b)	54.1 (9.3)	54	HCP / research team	Unclear frequency	Not targeted	Patients chose when messages were sent	Patients' identifiable self-care needs for long-term condition	Positive	Interviews	Patients felt supported in organising their self-care and improving their self-efficacy.
Glanz et al. (2012)	63.13(9.06) IG; 62.11(9.26) CG	37.5	HCP / research team but could be initiated by patient	Every two then 3, then 4 weekly – stepped down every 3 months	Patients identified as non-adherent	Used patients' medication-taking schedule.	Patients' identifiable barriers to medication adherence Authors state tailoring to health literacy level, race and culture.	Positive	Questionnaire	>85% respondents rated calls easy to understand, 78-85% as interesting, personally relevant and helpful
Nelson et al. (2016a) and Nelson et al. (2016b)	50.05 (10.53)	67.5	HCP / research team	Twice daily for SMS, weekly for IVR	Not targeted	Patients chose when messages were sent	Patients' identifiable barriers to medication adherence	Positive	Engagement in the study	Intervention group responded to 84% (IQR 80.8-96.3%) of 2 way text messages and 57.1% (IQR 32.1-86.2%) IVR calls.
Spoelstra et al. (2016)	60.1 (10.1) IG; 59.9 (11.2) CG	54.7	HCP / research team	Variable based on dosing regime.	Those newly prescribed oral anticancer agents	Used patients' medication-taking schedule.	None	Positive	Questionnaire; Engagement in the study	90% satisfied, finding reminders helpful. High read rate (88%).

Study	Age Mean (SD)	Female (%)	Contact initiated by	Frequency of contact	Targeting	Personalisation	Tailoring	Patient acceptability	Patient acceptability assessed?	Patient acceptability summary
						and names of patients' medication				
Garofalo et al. (2016)	24.1 (2.9)	17.1	HCP / research team	Depending on medication regimen	Poorly adherent youth living with HIV	Used patients' medication-taking schedule. Personalised as patient chose the message that they received	None	Positive	Questionnaire	100% stated that they would recommend the intervention to others
Pfaeffli Dale et al. (2015)	59.5 (11.1)	18.7	Mixture of patient and HCP / research team	Daily (7 days/ week for 12 weeks then 5 days/week)	Patients who had recently had a cardiac event	Used the patient's name in messages. Patients chose when messages were sent	None	Positive	Questionnaire	85% read all messages; 84% felt there was right number of messages sent and 90% would recommend to someone else
Park et al. (2014) and Park et al. (2015)	59.2 (9.4)	24	HCP / research team	Daily or twice daily for statin/ antiplatelet, three times a week for education.	Patients recently admitted to hospital for IHD events	Used the patient's name in messages. Patients chose when messages were sent.	None	Positive	Questionnaire	Over 80% positive for reminders, education and feeling cared for (over 70% in reminder and education).
Auger et al. (2013)	Median 67 (11.6)	46.5	HCP / research team	2 calls (day 3 and day 17)	Not targeted	Used the patient's name and	None	Positive	Engagement in the study, questionnaire	70% of patients completed first IVR call

Study	Age Mean (SD)	Female (%)	Contact initiated by	Frequency of contact	Targeting	Personalisation	Tailoring	Patient acceptability	Patient acceptability assessed?	Patient acceptability summary
						GPs name in messages				
Boland et al. (2014)	69.6 (13.6) IG; 62.7 (12.1) CG	55% intervention; 47% control	HCP / research team	Daily	Patients identified as non-adherent	Referenced patients' specific medication. Patients chose when messages were sent	None	Positive	Questionnaire	84% strongly or somewhat agreed that the reminders were helpful.
Leu et al. (2005)	51 (Not given)	Not given	HCP / research team	3.2 daily (average)	Patients with uncontrolled diabetes	Patient chose the message that they received. Patients chose when messages were sent	None	Positive	Questionnaire	Pager group felt the messages were comforting, helpful, convenient, useful and felt cared for.
Sherrard et al. (2015)	62.3 (11.3) IG; 63.8 (11.8) CG	27.4	HCP / research team	1,3,6,9,12 months post discharge	Not targeted	None	None	Positive	Engagement in the study, questionnaire	Over 80% of patients said the IVR system was helpful, that they would use it again and that it was a good way of following them up post-discharge

Study	Age Mean (SD)	Female (%)	Contact initiated by	Frequency of contact	Targeting	Personalisation	Tailoring	Patient acceptability	Patient acceptability assessed?	Patient acceptability summary
Vollmer et al. (2014)	63.6 (12.2)	47	HCP / research team	Unclear frequency – when a prescription refill was due	Patients identified as non-adherent	None	None	Positive	Questionnaire; Interviews	70% liked calls with only small percentages finding them annoying (8%). 94% stated that calls were useful.
Sherrard et al. (2009)	64.5 (Not given) IG; 62.4 (not given) CG	Not given	HCP / research team	1,2,3,4,6,8, 1,16,20 and 24 weeks	Patients receiving Coronary Artery Bypass Graft or valve surgery	None	None	Positive	Engagement in the study, questionnaire	90% of patients satisfied with IVR-generated medication information, only 2.9% felt they needed further information
Katelenich et al. (2015)	59 (Not given)	60	HCP / research team	At least once daily	Patients on insulin with uncontrolled diabetes.	None	None	Positive	Questionnaire	82% liked idea of physicians interacting with them using TMs/ IVR and 91% felt helped to manage diabetes
Shane-McWhorter et al. (2014)	50.6 (Not given)	58.7	Mixture of patient and HCP / research team	Daily	Patients with uncontrolled diabetes (and/or uncontrolled hypertension	None	None	Positive	Questionnaire	Telemonitoring monitoring useful (94.4%) and patients were satisfied with experience (97.2%)

Study	Age Mean (SD)	Female (%)	Contact initiated by	Frequency of contact	Targeting	Personalisation	Tailoring	Patient acceptability	Patient acceptability assessed?	Patient acceptability summary
Cottrell et al. (2015)	Not given	Not given	Unclear	Varied according to protocol (multiple included)	Unclear	None	None	Positive	Retention in the study, engagement in the study, questionnaire	Patient activity good at month 1 for hypertension (71-80%) but reduced over 2-3 months (31-60%). 80% agreed friends and family statement.
Vollmer et al. (2011)	53.6 (15.3)	66.2	HCP / research team	Monthly	Patients identified as non-adherent	None	Patients' identifiable barriers to medication adherence	Neutral	Questionnaire	Around 50% of respondents said that the calls were helpful.
Boker et al. (2012)	22.6 (Not given)	60	HCP / research team	Twice daily	Not targeted	Used the patient's name and medication in messages. Patients chose when messages were sent	None	Neutral	Questionnaire	33% of patients said that they ignored TM after 2 weeks, with 26% reporting them as "annoying".
Harris et al. (2010); Simoni et al. (2010); Yard et al. (2011)	40 (8.2)	23.7	HCP / research team	Variable	Patients with new or recently changed HAART	Used the patient's name and medication in messages and used their medication-taking schedule	Patients' identifiable barriers to medication adherence and self-care for long-term condition	Negative	Engagement in the study, questionnaire, focus groups	Relatively low response rate to text messages (42.8%) which lowered over the course of the intervention.

Study	Age Mean (SD)	Female (%)	Contact initiated by	Frequency of contact	Targeting	Personalisation	Tailoring	Patient acceptability	Patient acceptability assessed?	Patient acceptability summary
Stuart et al. (2003)	Not given	Not given	HCP / research team	Daily for 2 weeks, then weekly for 10 weeks	Patients newly prescribed medication	None	None	Negative	Retention in the study; questionnaire	50% of patients did not initiate or complete the 12 week intervention.
Piette et al. (2015)	67.8 (10.2)	0.6	HCP / research team	Weekly	Patients with uncontrolled heart failure	Patients chose when messages were sent	Patients' identifiable self-care needs for long-term condition	Not studied	Not studied	Not studied
Piette et al. (2000)	56 (10) IG; 53(10) CG	58.9	HCP / research team	Twice a week	Not targeted	Patients chose when messages were sent	Patients' identifiable self-care needs for long-term condition	Not studied	Not studied	Not studied
Stacy et al. (2009)	54.4 (Not given)	62.4	HCP / research team	Unclear frequency (3 calls total)	Not targeted	None	Patients' identifiable self-care needs for long-term condition	Not studied	Not studied	Not studied
Aikens et al. (2015b/c)	66.6 (9.8)	3	HCP / research team	Weekly	Patients identified as non-adherent	Patients chose when messages were sent	Patients' identifiable barriers to medication adherence and self-care for long-term condition	Not studied	Not studied	Not studied

Study	Age Mean (SD)	Female (%)	Contact initiated by	Frequency of contact	Targeting	Personalisation	Tailoring	Patient acceptability	Patient acceptability assessed?	Patient acceptability summary
Bender et al. (2010)	39.6 (12.8) IG; 43.5 (14.3) CG	64	HCP / research team but could be initiated by patient	Monthly	Not targeted	None	Patients' identifiable barriers to medication adherence and self-care for long-term condition	Not studied	Not studied	Not studied
Aikens et al. (2015a)	51.4(12.7)	78.6	HCP / research team	Weekly	Patients at risk of being non-adherent	None	Patients' identifiable barriers to medication adherence and self-care for long-term condition	Not studied	Not studied	Not studied
Zabinski et al. (2012)	56.2 (8.3) IG	58.7 (IVR Group)	Unclear	One-off	Patients identified as non-adherent	None	Patients' identifiable barriers to medication adherence	Not studied	Not studied	Not studied
Mayberry et al. (2017)	50 (10.5)	68	HCP / research team	Twice daily (SMS) and weekly (IVR)	Not targeted	None	Patients' identifiable barriers to medication adherence	Not studied	Not studied	Not studied
Wald et al. (2014)	Median (IQR) 60 (54-58) IG; 61 (49-69) CG	45.8	HCP / research team	Daily for 2 weeks, alternate days for 2 weeks, weekly for 22 weeks	Not targeted	Used patients' medication-taking schedule.	None	Not studied	Not studied	Not studied

Study	Age Mean (SD)	Female (%)	Contact initiated by	Frequency of contact	Targeting	Personalisation	Tailoring	Patient acceptability	Patient acceptability assessed?	Patient acceptability summary
Moore et al. (2015)	48.4 (9.2) IG; 45.9 (10.2) CG	16	HCP / research team	Multiple per day depending on medication schedule	Not targeted	Used patients' name and medication in messages. Patients chose the message and when messages were sent	None	Not studied	Not studied	Not studied
Cizmic et al. (2015)	71.4 (10.9) IG; 71.5 (10.6) CG	93	HCP / research team	One-off – IVR	Patients identified as non-adherent	None	None	Not studied	Not studied	Not studied
King et al. (2017)	Median (IQR) 39(29-47)	90	HCP / research team	Weekly	Patients at risk of being non-adherent	None	None	Not studied	Not studied	Not studied
Magid et al. (2011)	65.1 (11.1) IG; 66.7 (12.2) CG	33.3	Patient	Weekly	Patients with uncontrolled hypertension	None	None	Not studied	Not studied	Not studied
Bove et al. (2013)	61(13.6) IG; 58.2 (13.5) CG	65	Patient	At least twice a week	Patients with uncontrolled hypertension	None	None	Not studied	Not studied	Not studied
Tucker et al. (2013)	37.25 (9.86)	39	Patient	Daily	Not targeted	None	None	Not studied	Not studied	Not studied

CG: Control Group; GP: General Practitioner; HAART: Highly Active Antiretroviral Therapy; HCP: Healthcare professional; IG: Intervention Group; IQR: Interquartile Range; IVR: Interactive Voice Response; SD: Standard Deviation; SMS: Short Message Service; TM: Text Messaging

5.4.2.8 Context: Tailoring

Tailoring was present in 13 of the included studies and involved changing the content of the intervention. This was most often based on an assessment of the patients' identified barriers to medication adherence (n=9) or self-care needs for their long-term conditions (n=8). This was achieved either using baseline screening questions or offering patients a choice of content where they could opt for information that they felt to be the most useful for them. Two of the studies in diabetes customized the messages patients received based on receipt of blood glucose results[239,262,274]. One further study claimed to tailor their intervention to a patients' race, culture and health literacy level[243].

Of the 11 studies which incorporated tailoring for barriers to medication-taking, eight incorporated these within their IVR scripts with only limited details available for review. The study by Zabinski et al.[259] used the ASK-20 questionnaire[275], a validated instrument for self-completion, to identify barriers to medication adherence. Nelson et al.[267,268] completed a literature search and expert review to compile 17 medication related barriers against which to target their intervention[276] for diabetes. Whilst no specific questions are provided as examples in the study by Stacy et al.[255] the authors describe these questions as based on the Health Belief Model, Social Cognitive Theory and the SRM[33]. This tailoring did seem to have a positive impact on medication adherence; but results were more mixed for clinical outcomes.

An alternative to tailoring interventions is to target specific patient groups. Examples of targeting can be found in Table 9. The use of targeting did not seem to affect acceptability of interventions. However, some interventions targeted at patients with uncontrolled disease, usually where patients' clinical monitoring indicated that they were outside of a standardised range, for example an elevated blood pressure or HbA1c results. This context for interventions seemed to find positive impact on clinical outcomes. The two studies which

targeted patients who had recently started new medication had more negative results for both medication adherence and clinical outcomes. Only one study aimed to maintain medication adherence, but this had positive results for all three outcomes [251]. All interventions targeting patients who were established to be non-adherent and aimed to improve medication-taking, found positive improvements in medication adherence outcomes and most of these also found improvements in clinical outcomes. Therefore, targeting patients already taking medication, either to improve or maintain medicines-taking behaviours could be a useful target for a future intervention. Using such interventions for newly initiated medicines however, is less clear.

One aspect which was lacking amongst the studies was an assessment of acceptability for the behavioural mechanisms included in interventions. Those studies targeting or tailoring interventions did not often report whether the methods by which they had altered the intervention delivery was acceptable to their participants and whether the resulting content felt tailored to their individual needs to support medication-taking.

5.4.2.9 Context: multiple long-term conditions

One of the key aims of the TIMELY intervention is to support patients taking medicines for multiple long-term conditions. The intervention studied by Zabinski et al.[259] was the only intervention to successfully target multiple long-term conditions by conducting a generic assessment of medication-taking. Two other studies evaluated known co-morbidity clusters, one for patients with diabetes and hypertension and the other for patients with HIV/AIDS and co-occurring bipolar disorder. Cottrell et al.[270] was a compilation paper which evaluated patient acceptability for several different interventions targeted at different long-term conditions. The paper by Auger et al. targeted patients newly prescribed one medication, but the intervention was generic enough to include a range of new medicines. However, no

studies sought to deliver content for multiple long-term conditions simultaneously, and so this was not able to be examined.

5.5 Discussion of narrative synthesis findings

The aim of the narrative synthesis systematic review was to identify the factors that create successful automated two-way digital communication interventions to influence medication-taking behaviour in patients. Coding interventions within the included studies allowed the behavioural mechanisms for automated two-way digital communication interventions to be identified and mapped to study outcomes.

The review highlighted several BCTs which may be helpful to increase reflective motivation for medication-taking delivered via text messaging. Feedback on outcomes of behaviour seemed particularly helpful, and this had evidence of delivery in several long-term conditions including: diabetes, hypertension, cardiovascular disease, depression, asthma, heart failure, COPD, chronic pain, chronic kidney disease and heart failure. The review also showed the potential for using symptom tracking or the BCT Biofeedback to achieve this. Inconclusive results around the use of the information about health consequences BCT require further exploration. The success of interventions in the out-patient setting suggested that the use of credible source as a BCT could be helpful.

The role of prompts/ cues needed to increase habit formation as part of the automatic motivation component of COM-B required further exploration as their inclusion did not necessarily lead to an improvement in medication adherence. However, the use of the BCT ‘feedback on behaviour’ would be further investigated as this could be combined with Problem solving and/ or Social reward BCTs. Both BCTs seemed to be linked to improvements in medication adherence, although the problem-solving element was often delivered via IVR rather than SMS.

The narrative synthesis also found that tailoring an intervention for identifiable issues associated with medication adherence or self-care might be an important contextual factor for a successful intervention. Though how this might also affect communication frequency, and what an acceptable frequency of communication with patients might be was still unclear. Allowing patients to make choices about the communication, for example choosing when messages are sent, also seemed to contribute to patient acceptability and is possible to incorporate using the Simple Telehealth software system so was considered for incorporation into the new intervention.

Linking interventions to obtaining medication seemed to be an important potential mechanism for interventions, so using community pharmacies as a context for delivery still made sense. However, whether targeting 'obtaining medication' should be included in the digital communication or the pharmacist consultation required further thought. The BCTs identified targeted at obtaining medication included instruction on how to perform the behaviour, and social support (practical); both had the potential to be achieved as part of the consultation or using text messaging.

There was also a small number of studies which used pharmacists to deliver the intervention, further supporting the feasibility of pharmacists to deliver the TIMELY intervention. However, there was little evidence for whether the addition of healthcare professionals to digital communication had any benefit. Therefore, exploring the role of a consultation with a community pharmacist required further work. There is also a question around whether such 'live' communication should be routine or initiated based on patient responses to the digital communication component. Within the review there were also no data available about professional acceptability for delivery of digital communication interventions with pharmacists, although other professionals using such interventions generally seemed to see them as a useful tool in delivering clinical care.

Patient engagement with the content delivered using the digital communication would be important, and the narrative synthesis provided evidence that such interventions can be acceptable to patients with a wide range of ages. Though it should be noted that interventions with some of the older age categories used IVR rather than text messages, so this required further testing with patients. There was also little evidence for what impact use of a persona for the communication makes on outcomes, and so this required further investigation.

Few studies examined the use of an automated two-way digital communication intervention in multimorbidity, which continued to be an aim for the TIMELY intervention. The potential for such interventions to be used in this context continued to require further examination. Zabinski et al.[259] highlighted the potential for using a generic assessment tool to tailor an intervention in multimorbidity which would warrant further investigation. Whether interventions should be targeted at patients identified as non-adherent or have the aim of maintaining medication adherence was still unclear.

5.5.1 Strengths and limitations of the narrative synthesis systematic review

Similar interventions to TIMELY developed more recently have also started with an examination of the peer reviewed literature. The SuMMiT-D trial[277] initially used a rapid review of systematic reviews of interventions to support medication adherence to identify candidate BCTs to include in their intervention[278]. However, as this process used reviews, the authors only used the literature for identifying potential 'constructs' and the 46 BCT candidates to include in the intervention were identified using a process of 'brainstorming'.

The Medication Adherence for Patient's Support (MAPS) study used a meta-analysis and meta-regression process to identify potentially effective BCTs using RCTs of automated digital communication interventions in patients with cardio-metabolic conditions[194]. This

review however did not fully adhere to the BCT Taxonomy[50], resulting in the conflation of potentially numerous BCTs under more simplified headings. The review did however re-emphasise the importance of tailoring interventions. The review by Patton et al.[51] for the S-Map intervention focused on evaluating theory-based interventions to identify potentially important behavioural components to interventions for their starting point. The emphasis on behaviour across all of these approaches, including my own, suggests that medication adherence is increasingly being examined through a behavioural lens.

A limitation to all these reviews, including my own,151iscomfr is the focus on mechanisms and outcomes, often overlooking the potential role of context. Realist synthesis is a method of literature examination linked to realistic evaluation (see Chapter 4). The aim of a realist synthesis is to understand the contexts, mechanisms and outcomes of an examined research question using a retroductive approach. The researcher starts with an initial search of the literature, but this is then supplemented by other searches to build up a programme theory through analysis of published studies. A realist synthesis could have been an alternative approach and could have been more useful to develop the realist programme theory for the TIMELY intervention. This could have enhanced intelligence from the peer-reviewed literature by examining the contexts of each study individually, in addition to the mechanisms and outcomes, rather than considering this across the included studies.

5.6 Programme Theory Second Iteration

Using evidence from the narrative synthesis systematic review, the TIMELY intervention programme theory was updated (see Figure 12). Compared to the first iteration programme theory (see Figure 7), there are now four behaviours to target as part of the TIMELY intervention with seven behavioural mechanisms identified, reflecting the behaviours and mechanisms identified in the review. The four behaviours are represented as sequential with a solid black arrow indicating the order in which they are required to be performed as part of

an overall medication-taking process. The arrow between the ‘self-testing’ and ‘asking for support’ arrow is a broken line to indicate that this final behaviour is only likely to occur if the self-testing behaviour reveals information that requires action. For example, a patient performing a home blood pressure monitoring (behaviour) which reveals a very high blood pressure reading, which indicates the need for seek treatment from a healthcare provider.

The COM-B elements for the taking medication behaviour are then highlighted and the mechanisms by which the TIMELY intervention is now anticipated to work are now separated into the specific medication-taking behaviour they target. Physical opportunity for taking medication is directly linked to supporting the behaviour of obtaining medication, reflecting the findings from the analysis from the narrative synthesis systematic review (see Section 5.4.2.3). Mechanism 2 and Mechanism 3 are retained from the first iteration of the programme theory (see Figure 7) however there was little information provided in the studies included in the review to identify any specific BCTs linked to these mechanisms (see Section 5.4.2.4).

Mechanism 4 was frequently included in the studied interventions, and there were several BCTs identified to increase reflective motivation to take medication (see Section 5.4.2.1). In the case of Mechanism 6 (Introduce self-testing to facilitate providing feedback on outcomes of taking medication), automated digital communication was identified to support the performance of the self-testing behaviour itself, and the outcomes from this behaviour fed into influence reflective motivation (Mechanism 4). This interaction between self-testing and reflective motivation for taking medication was therefore included into the design for the TIMELY intervention. To reflect the mechanisms used in the studies from the narrative synthesis systematic review, the BCT Prompts/ cues was suggested for targeting the self-testing behaviour, along with Adding objects to the environment in the form of home monitoring devices.

There were also several BCTs examined to support Mechanism 5 to increase habit formation for taking medication (see Section 5.4.2.2). As the Feedback on behaviour BCT seemed to be more effective at improving medication adherence compared to Monitoring behaviour by other without feedback, the former was included into the TIMELY programme theory. As were other BCTs which seemed to be effective based on the analysis from the review, including: 'Problem solving', 'Social reward', and 'Prompts/cues'.

Mechanism 7 reflects the ongoing role for non-digital support for medication-taking behaviours by patients performing the behaviour 'asking for support'. However, the details of what support was provided in interventions contained little detail, including when patients were prompted to ask for support or why. The review also could not conclude whether or not this additional support was important for intervention effectiveness. And therefore no specific BCTs to target this behaviour were included in the TIMELY programme theory at this point. However, the delivery context of a community pharmacy was separated to acknowledge the need for ongoing pharmacy support alongside a digital intervention in addition to a medication review with a community pharmacist.

However, if these BCTs and mechanisms would be effective or not remained somewhat unclear, reflecting the differing results across the studies examined in the review. Also, as most of the studies included in the review often did not frame medication adherence as a behavioural problem, the identification of behaviours, COM-B mechanisms and BCTs was completed as part of the analysis process, informed by the mapping to COM-B by Jackson et al.[44], rather than being directly described by the intervention designers themselves. To check that this analysis of medication-taking behaviours and potential mechanisms to support these would be suitable for the TIMELY intervention, they would require further exploration with patients and healthcare professionals. This would be completed as part of the co-design of intervention concept study (in Chapter 6) and the co-design of intervention

delivery with patients study (see Chapter 7). This would be important as the final intervention components should be informed by a full understanding of the target behaviours.

This second iteration programme theory provided a basis to develop prototypes (see Section 4.5) for the subsequent study which developed an intervention concept for testing with patients and healthcare professionals (see Chapter 6). These prototypes combined use of the behavioural mechanisms identified in the review with behavioural mapping to inform theoretically based selection of other BCTs likely to be helpful to inform medication-taking behaviours. This subsequent study also allowed some of the issues identified from the narrative synthesis systematic review to be explored in the design process for the new intervention to support medication adherence, using two-way automated text messaging delivered from the community pharmacy setting.

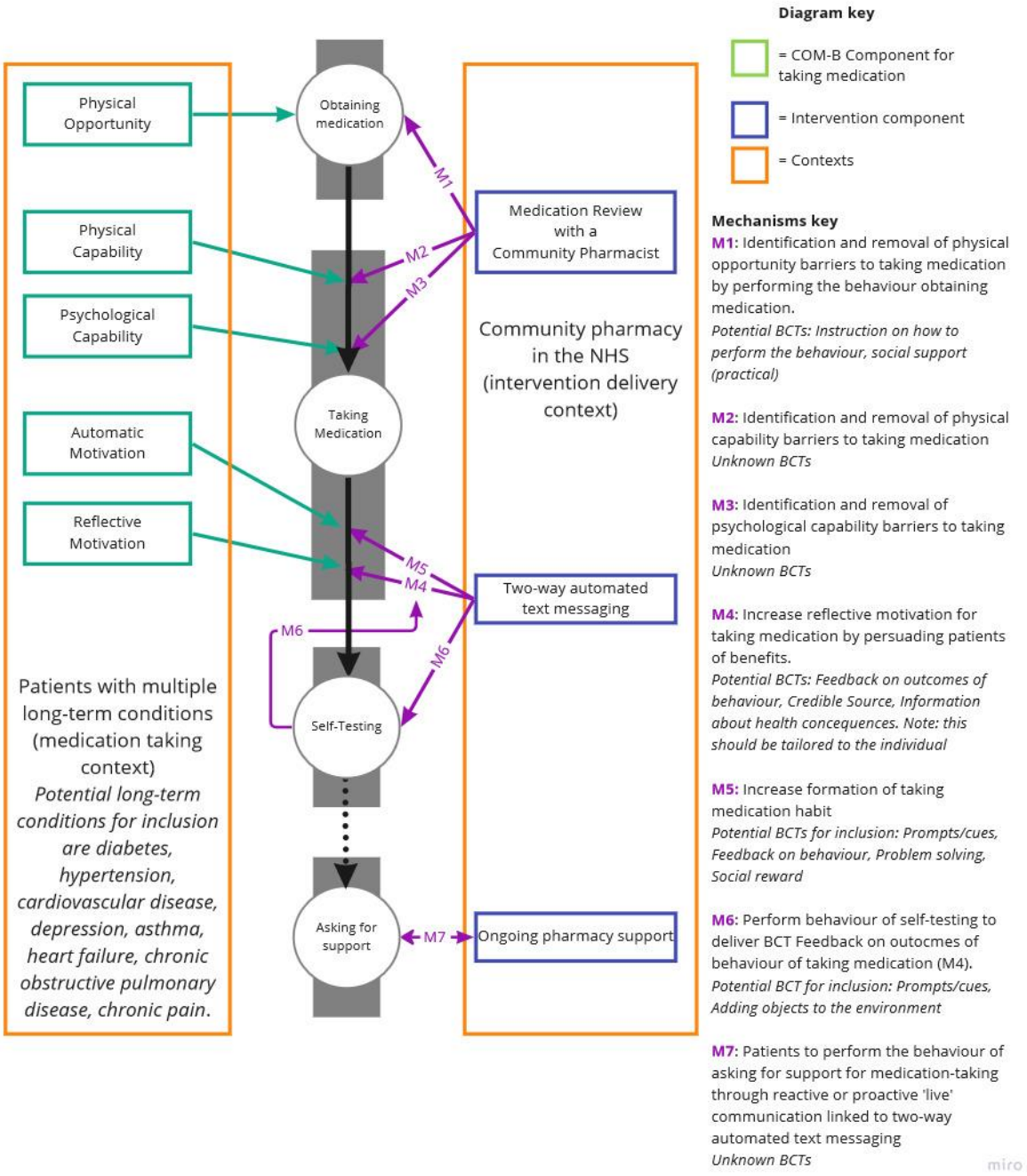


Figure 12 Second iteration of a programme theory for the TIMELY intervention following narrative synthesis systematic review

Chapter 6 Co-design of intervention concept with patients and healthcare professionals

This chapter presents the prototype development, data collection methods, results and discussion for the work package which created and gathered feedback on an initial design concept for a new intervention combining automated two-way text messaging and a community pharmacist consultation. To co-design the new intervention concept, I used prototypes (introduced in Chapter 4) and focus groups with modified Nominal Group Technique (NGT). Feedback was sought from patients, pharmacists, General Practitioners (GPs), practice nurses and practice pharmacists. Qualitative analysis of the focus groups was used to generate statements which were then ranked by participants. The results of the ranking led to the identification and prioritisation of changes for the intervention and ensured the preservation of aspects of the intervention that participants liked. The findings from this study led to changes which are detailed in this chapter, before further co-design processes with patients (Chapter 7), community pharmacy staff (Chapter 8) and general practice staff (Chapter 9). For clarity, the new intervention concept which combines automated two-way text messaging and a community pharmacist consultation will now be referred to as the 'TIMELY' intervention.

6.1 Prototype development for the intervention concept

Prototype development for the TIMELY intervention concept was grounded in the findings of the narrative synthesis systematic review. Six prototypes were developed for the purposes of gathering feedback on the design. Three of these were designed to generate feedback from patients, two specifically for healthcare professionals and one was tested across both groups. Selection of prototypes to be developed was based on the experience map generated as part of the Human Centred Design (HCD) process (see Section 4.5.2). A detailed description for how each of the six prototypes was developed is provided in the following section with a summary of how each prototype linked to the experience map and

access to each individual prototype is available in Table 10 with paper based prototypes also available in the appendices.

6.1.1 Video of pharmacy assistant inviting a patient to receive the TIMELY intervention

A video was created to demonstrate how patients might be invited to receive the TIMELY intervention. The invitation was demonstrated as linked to medication supply to represent an opportunistic approach to recruitment. A script was created using language to reflect an open invitation without any prior assumption of medicines-taking performance by the patient. The intervention was framed to support motivation with medicines-taking, aligned with the underpinning programme theory for the intervention design. The video was recorded in a simulated pharmacy environment with a volunteer pharmacy student and patient researcher (PMc). The same patient (PMc) was used in both the pharmacy invitation video and pharmacist consultation video to help tell the story of the patient experience of the intervention.

6.1.2 Personalisation Questionnaire

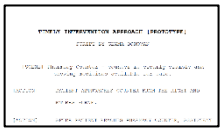
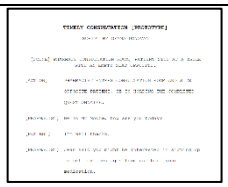
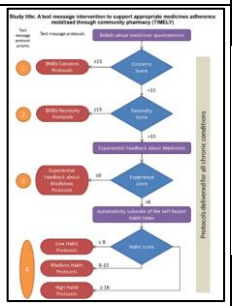
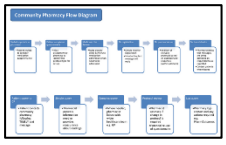
The systematic review (Chapter 5) highlighted the positive impact of tailoring automated two-way digital communication interventions, and so a personalisation questionnaire prototype was created to facilitate this tailoring for the TIMELY intervention. This tailoring was specifically linked to delivering Mechanism 4 to increase patients' reflective motivation to engage with medication taking (see Figure 12). Studies from the systematic review which used tailoring were evaluated to design the personalisation questionnaire. This included a review of the ASK-20 questionnaire used by Zabinski et al.[259] and medication adherence barriers questionnaire used by Nelson et al. [267,268]. However, neither of these offered a tool which could be used in the context of multimorbidity.

Whilst Stacy et al.[255] provided no details of their personalisation approach, they did make use of the Self-Regulatory Model, upon which the Beliefs about Medicines Questionnaire

(BMQ) is based (see 2.2.2). The BMQ also aligns to the second iteration of the programme theory that medication beliefs can be influenced to increase reflective motivation towards medicines-taking. This was therefore used as one component of the personalisation questionnaire. However, the second iteration of the programme theory also suggests that habit strength may also be an important predictor of medication-taking behaviour. The Self-Reported Habit Index (SRHI) [279] has been validated as a measurement of habit strength and has been compared to medication-taking and correlated with medication adherence. More recently, the automaticity subscale of the SRHI (A-SRHI) had been found to be the most predictive component of the SRHI for medication adherence habit strength[42]. Philips et al.[40] combined A-SRHI with BMQ and two questions which assess patients' perceptions of medicine effectiveness to further predict medication nonadherence. Perceived efficacy of medicines is contained within the necessity statements of the BMQ[34], but is a distinct construct within this[280]. To account for this, Phillips et al.[40] created two separate questions about perceived effectiveness of medication in their study using a binary yes/no response for one question and a three point scale for the second question. However as both the BMQ and A-SHRI are both rated on a five-point Likert scale, the question about experience of medicines effectiveness from the work by Phillips et al.[40] was transformed to a Likert scale to match the other items. Combining these approaches in this study enabled an assessment of reflective and automatic motivation influences on taking medication which could then be used as a basis for tailored text message content.

To supplement questions around motivation for taking medication, practical questions were included which would screen patients to ensure that they were appropriate candidates for a text messaging programme. These included questions asking about mobile phone signal and ability to use text messaging. The questionnaire also needed to ensure that Behaviour Change Techniques (BCTs) that were identified for potential inclusion in the TIMELY intervention from the narrative synthesis systematic review could be delivered to individual patients.

Table 10 An overview of the design questions and prototypes for the intervention concept co-design study

Design question from experience map	Prototype to be used	Click to view prototype	Scan to view prototype	Feedback group
What is the best way to approach patients who may benefit from TIMELY intervention? What would encourage patients to find out more?	Video of pharmacy assistant inviting patients to the intervention			Patients
How would assessment of barriers to medication adherence happen?	Personalisation questionnaire			Patients
What information will the patient need before setting up the TIMELY intervention?	Patient information leaflet for the intervention			Patients
How should the TIMELY consultation be structured?	Video of pharmacist consultation			Patients and HCPs
How would assessment of barriers to medication adherence happen? Which patients do we want to target for the TIMELY intervention?	Principles for intervention personalisation document			HCPs
What happens if the pharmacist sets up the wrong protocols? What happens if the pharmacy needs to refer the patient to another healthcare professional?	Flow diagram of integration pathway			HCPs

Note: HCPs: Healthcare professionals

For example, to deliver the BCT prompts/ cues for taking medicines, questions were included which would allow pharmacists to identify appropriate times for these messages to be delivered. Information was also gathered about home self-monitoring equipment to deliver the BCT feedback on outcomes of behaviour. Some introductory text was also added with instructions on how to complete the personalisation questionnaire alongside a consent statement to allow pharmacists to use their medication records for the purposes of setting up text messages for the patient.

6.1.3 Patient Information Leaflet (mock-up prototype)

The mock-up patient information leaflet was drafted based on text from an existing leaflet from the Simple Telehealth Community[281]. Amendments were made only to adapt the leaflet for an intervention which focused on supporting taking medicines and being delivered from a community pharmacy setting. The leaflet was formatted using the online graphic design software Canva[282].

6.1.4 Video of pharmacist consultation

A consultation for the TIMELY intervention was designed based on a Medicines Use Review (MUR). The medication review was design to deliver mechanisms linked to helping patients to obtain their medication (and thus remove a physical opportunity barrier to medication taking), identify and remove physical and psychological capability barriers to taking medication. These mechanisms already existed within the MUR framework (as described in Section 2.3.1) and so were retained for the proposed consultation for the TIMELY intervention in this prototype. However, to link this to support using the automated two-way text messaging, additional components were added using the current model of incorporating Simple Telehealth into general practice settings. This included:

- Registering the patient on the Simple Telehealth system
- Acquiring information required to set up text messaging protocols

- Providing information to support engagement with the text messaging intervention

A script was created, and this was then recorded to create the community pharmacist consultation video.

6.1.5 Principles for intervention personalisation document

To represent how the personalisation questionnaire would feed into text message protocol allocation, a diagram prototype to represent this was created. This was based on the second version of the TIMELY programme theory which had been refined following the systematic review (see Section 5.6). However, additional BCTs were also incorporated using the guidance from the BCW[157] (as described in Section 4.4).

To stratify patients according to their potential BCT needs, the responses from the questionnaire were separated into different motivation categories that may be influencing medication-taking behaviour. The diagram from the prototype which outlines these categories and the order in which they are resolved can be found in Figure 13. First, patients who are concerned about their medicines were created as a group. Patients would be placed into this 'concerns' category if they indicated strong agreement with concerns about medicines statements from the BMQ by having a score of 15 or more. Horne has also suggested the mid-point score of a BMQ subscale can be used to categorise patients into opposing ends of the scale[34]. These patients would receive content which aimed to reduce their concerns about medication or encourage them to discuss concerns with the pharmacist. From research using the BMQ, one of the key concerns people have about medicines is side effects[283], therefore educating patients about potential side effects or providing reassurance could be used to reduce these concerns. This would deliver the BCT 'Reduce negative emotions'. Other suggested BCTs that were included in the prototype for this group included 'Commitment', 'Monitoring of emotional consequences', and 'Framing/ reframing'. However, as some of these concerns may be legitimate, it was also important that patients were encouraged to discuss concerns which continued with their healthcare

professional, potentially with a view to deprescribe problematic medicines. This would deliver the BCT ‘Social support (unspecified)’.

The second group of patients who were separated as a group were those who had a low score for perceived need for medicines from the BMQ. Again, using a mid-scale cut-off point, patients would be placed into this category if they had a score of 15 or less (because the lower the number the lower the perceived need for medication). Text messaging content in this group would aim to draw on the ‘Persuasion’ intervention function and use BCTs such as Information about health consequences, Salience of consequences, Information about social and environmental consequences and Credible source. These aimed to increase the perceived need for medication by patients.

A third group was identified using the responses from the experiential feedback about medicines questions drawn from the work by Phillips et al.[40]. The original scale used two questions with different scales, the question “Have you noticed the positive benefits of the medication?” was answered using a binary yes or no response. The second question “Have you experienced any solid/ convincing evidence that the diabetes medication does what it is supposed to do?” was answered using a scale of ‘no evidence’ = 1, ‘some evidence’ = 2 or ‘solid evidence’ = 3. The authors acknowledged that this scale had relatively low reliability. With the conversion of these responses to a Likert scale to create consistency with the other instruments, I chose to also use a mid-point cut off scale similar to the approach with the BMQ items, with patients being placed in a low perceived medication effectiveness category if they had a score of 6 or less on this scale. To counter this perception in patients in this category, content for the text messaging protocol would be designed to draw attention to the impact that taking medicines was having on health. Using both the ‘Education’ and ‘Persuasion’ intervention functions, BCTs for this group were suggested as Goal setting (outcome), Review outcome goal(s), Self-monitoring of outcome(s) of behaviour, Biofeedback, Feedback on outcome(s) of behaviour and Behavioural experiments.

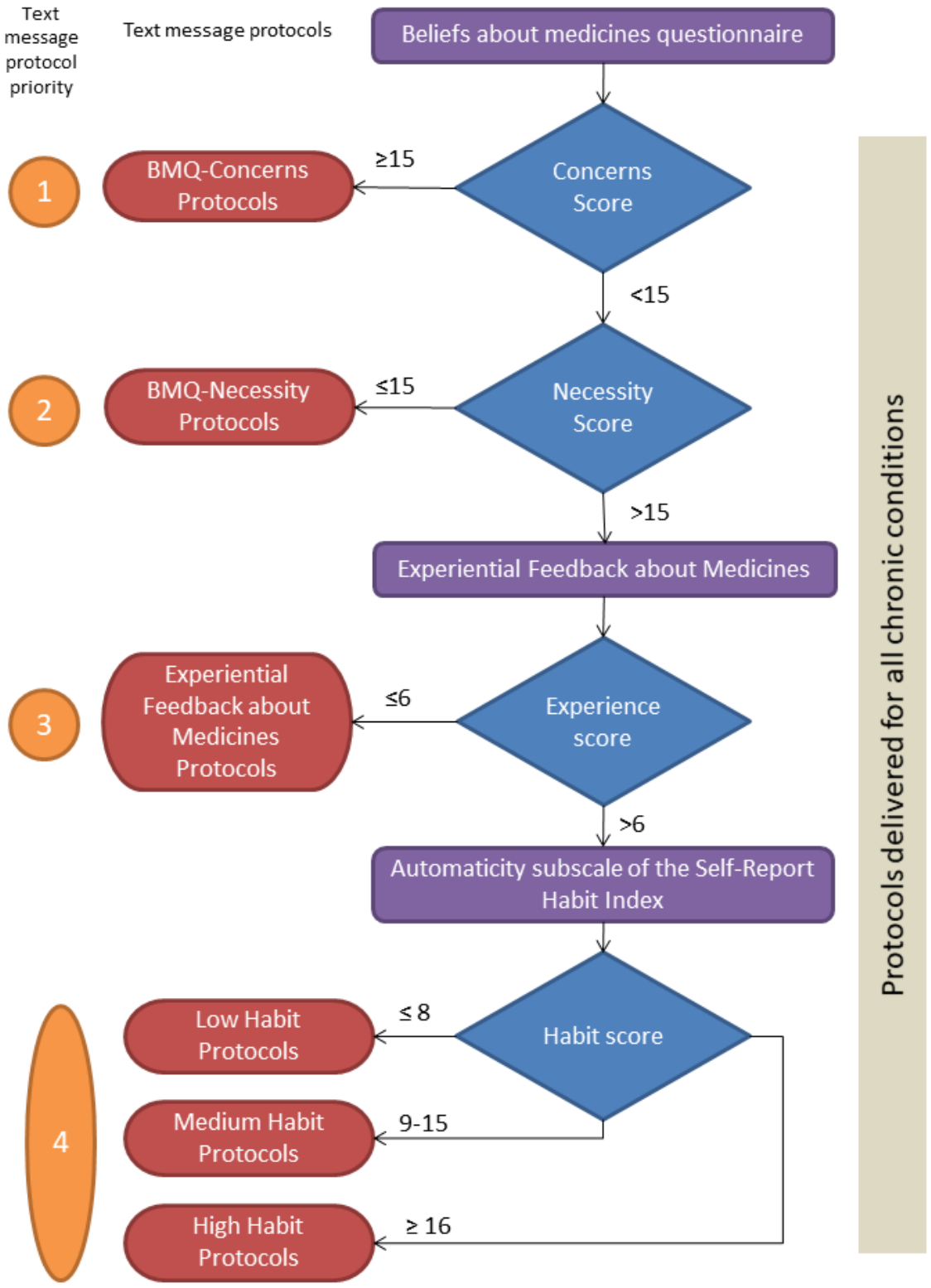


Figure 13 Text message protocol selection flow diagram from the 'Principles for intervention personalisation document' prototype

The final groups were drawn from habit strength indicated from completion of the A-SRHI questions. In this part of the prototype, habit strength was separated into ‘Low’, ‘Medium’ and ‘High’. Although both Phillips et al.[40] and Aarts et al.[284] make reference to the relative importance of ‘high’ and ‘low/weak’ habit strength, they did not relate this back to any score values on the A-SHRI. Patients with different levels of habit strength may require different BCTs and therefore different protocols were created for feedback. For those with a ‘Low’ habit strength, the initial design concept placed an emphasis on the BCT ‘Prompts/cues’ with supporting BCTs ‘Monitoring of behaviour by others without feedback’, ‘Goal setting (behaviour)’, ‘Review behaviour goal(s)’, ‘Discrepancy between current behaviour and goal’, ‘Feedback on behaviour’ and ‘Social reward’. For those with a ‘Medium’ habit, more emphasis was placed on monitoring BCTs including: ‘Monitoring of behaviour by others without feedback’, ‘Self-monitoring of behaviour’, ‘Behavioural practice / rehearsal’, ‘Habit formation’ and ‘Adding objects to the environment’. In those with ‘High’ habit strength the aim would be to maintain this good habit by using the BCT ‘Monitoring of behaviour by others without feedback’.

The next phase was to prioritise the order In which patients would be allocated to one of these groups. Horne’s[34] expansion of the SRM highlights that coherence around taking medicines is cyclical, with treatment related beliefs triggering actions, and then experiential feedback from medicines feeding back into treatment related beliefs. Philips et al.[40] expanded on this by adding in the role of habit. They initially argued that habit formation for taking medicines can only begin once medication coherence has been achieved. Whilst their results indicated that habit was correlated with taking medicines regardless of medication beliefs, habits can only be established if intentional barriers to medication adherence are minimised, and these were well predicted by the BMQ items. This suggested that addressing issues around treatment beliefs where these may be problematic should take precedence over habit formation influence. Fear around medicines, potentially caused by strong

concerns, contributes to the automatic motivation of taking medicines in the second iteration programme theory. Automatic motivation drivers are linked more to the subconscious and have the potential to undermine higher cognitive processes associated with reflective motivation[285]. There is also increasing recognition that many patients may be on too many medicines[286] , therefore, prompting patients to discuss concerns with a healthcare professional could trigger a medication review and deprescribing process that would be beneficial to the patient and their health outcomes. Combined, this suggested the case for making the concerns group the highest priority.

In between the concerns group being the highest priority and the habit groups being the lowest priority, were the group who had a low score for perceived need for medication and those with a low score for belief that their medicines work. In a scenario where patients do not take their medicines, and this could be due to a low perceived need for medication, it would be more difficult to demonstrate effectiveness. Thus, a natural prioritisation of these groups to determine text messaging content was created:

- Where there is high score for concern about medicines, text messaging protocols should tackle this first;
- Where there are no concerns, but a low perception of need, protocols should be delivered which aim to increase this perceived need;
- Where there are no concerns, and perceived need but medicines are not thought to work, protocols should increase awareness of medicine effectiveness;
- Where there are no concerns, a perceived need for medicines and a belief that they are working, text messaging protocols should aim to increase habit strength

However, the aim was to also deliver content for multiple long-term conditions. Both the BMQ and the A-SRHI have been designed for use in multimorbidity. The BMQ has also shown that beliefs about a person's individual medicines is linked to their wider perception about medicines in general. Therefore, any perceptions about their medicines would be likely

transferable to medicines for each of their long-term conditions. Whilst there is no evidence for this transferability for the experiential feedback about medicines questions, the SRM shows a direct relationship between treatment beliefs and feedback from taking medicines. Assessment of treatment beliefs for each individual long-term condition and/or medication would likely make the TIMELY intervention impractical to deliver. Therefore, the text message protocol group that the patient was matched to based on the personalisation questionnaire, the equivalent content was suggested for delivery for all long-term conditions the patient had.

The personalisation questionnaire components, suggested thresholds, groups and priority were represented in a flow diagram on the first page of the prototype for the principles for intervention personalisation document. This was then broken down on subsequent pages for each of the patient groups to show the questions and scoring for responses alongside the suggested score threshold. A list of the suggested BCTs which could be delivered to that group and a suggested text message which would deliver that BCT was also provided. The text messages were drawn from examples already being used in the Simple Telehealth community and my own application of the behaviour change principles laid out in the Behaviour Change Wheel (BCW). Potential limitations of the text messaging software to facilitate delivery of BCTs were beyond the scope of this study but would be considered in the delivery study (see Chapter 7).

6.1.6 Flow diagram of integration pathway

The flow diagram of integration (available in Table 10) included a suggested model for how the TIMELY intervention could work in the community pharmacy and how wider primary care could also respond to queries from patients receiving the intervention. The diagram was based on pharmacy services and the current model of Simple Telehealth use in general practice.

The first page of the prototype shows the suggested process for patient initiation for the TIMELY intervention in the community pharmacy setting. The process reflects the suggested approach used in the 'video of pharmacy assistant inviting patients to the intervention' prototype used with patients, the use of the personalisation questionnaire, and the pharmacist consultation, including the set-up of a patient and allocation of text messaging protocols using the 'Principles for intervention personalisation document' (all available in Table 10). Following text-message setup as described in the pharmacist consultation video, the flow diagram suggested technical checks to check that the right text messaging protocols had been set-up for the patient.

The second line on the first page of the prototype suggested how a pharmacy might respond to a patient query as a result of receiving a text message. The prototype outlined pharmacists being able to handle most 'simple' queries, for example questions about side effects or how medicines should be used. However, where a query from a patient might require changes to medication, the flow diagram indicated that the pharmacist should liaise with the wider primary care team. Following a query from a patient during the text messaging programme, the flow diagram also suggested a review of the allocated text messaging protocols to ensure that the messages being sent were still appropriate for the patient. The software system PharmOutcomes was also suggested as a tool to support record keeping for any patient queries.

PharmOutcomes[287] is a web-based application which is now widely used in community pharmacy settings to record the delivery of services. It has also been developed to allow for cross-organisational referrals and has the facility to send automatic notifications to general practices securely using the nhs.net email service. It has been used, for example, to send notifications of influenza vaccinations to general practices where these have been administered by a community pharmacy. Automatic notifications to general practice weren't included in the prototype but were included for exploration as part of the topic guide for the

focus groups. Including the potential use of PharmOutcomes in the integration pathway for record keeping allowed exploration of potential acceptability of the software with pharmacist participants in the focus groups.

Th168iscomforpe also included suggested an integration pathway for how the wider healthcare team might respond to queries from patients resulting from the TIMELY intervention. This highlighted the functionality of the Simple Telehealth software to be accessed by all healthcare professionals to whom the patient authorises access. The prototype also suggested use of a website to provide information about the intervention to the wider healthcare team. This prototype therefore presented ideas for how general practices and community pharmacies could communicate about the intervention when delivering care to the same patient.

6.2 Focus groups with modified nominal group technique method to gather feedback on new intervention concept

Following guidance on complex intervention development[144], it was important to involve patients who would receive the intervention, community pharmacists who would deliver the intervention and the wider primary care team also caring for the patient in the design process for the intervention concept. This was achieved by gathering feedback on the designed prototypes using focus groups with modified Nominal Group Technique (NGT). This would combine qualitative feedback on prototypes with a consensus exercise. The consensus exercise was included due to potential for conflict in views. The combination of qualitative feedback and ranking using NGT allowed all individual views to be captured, but a filter for suggested changes to be applied through a prioritization exercise.

NGT is a consensus method which normally takes place within a single group of participants. Within the group, an exploratory question is posed, and some direction is provided by a

facilitator as to the types of responses required from participants[288]. Participants are asked to generate ideas silently by writing them down. This is followed by a 'round-robin' of sharing these ideas which are usually captured on a communal space such as a flipchart. These ideas are discussed and grouped together before participants are asked to rank the ideas generated by importance. In the original model, this ranking would lead to further discussion and the re-ranking of the ideas to achieve consensus amongst the group. NGT has been used previously within pharmacy research to explore the opinions of health professions and patients on pharmacy practice and develop evidence based guidelines[289].

The NGT model required adaptation in this study to be able to reconcile potential differences in feedback from the different groups included in the study. This was done by conducting the ranking process remotely using a questionnaire, following an interim analysis of the initial focus group data. The focus groups ran separately for patient and professional participants because the prototypes which had been developed to represent different aspects of the intervention design had different audiences for feedback (see Table 10). However, in the interim analysis stage, feedback from each of the groups was fed into the ranking statements for the appropriate prototype, rather than based on the group from where the feedback was provided. Examples of this will be discussed in the results.

6.2.1 Participants

The aim was to recruit participants who could provide feedback based on their personal experience to help develop the TIMELY intervention design. For patients this meant that they needed to be actively using a mobile phone and be self-managing a long-term condition. For healthcare professionals, it needed to be someone who was currently providing patient-facing care. The following inclusion and exclusion criteria were:

Patient participant inclusion criteria:

- 18 years of age or older

- Experience at least one long term condition, for which they are prescribed at least one medication
- Own a mobile phone capable of sending and receiving text messages
- Able to understand, read, write and speak English
- Willing to participate

Professional participant inclusion criteria:

- 18 years of age or older
- Currently practicing as a healthcare professional in a patient-facing role within the primary care setting
- Able to understand, read, write and speak English
- Willing to participate

6.2.1.1 Sampling

A convenience sampling approach was used to allow the recruitment of participants within a reasonable timescale, and because a targeted approach to sampling was not felt to be needed at this stage in the development process. The target sample size was 10-20 patients and 10-20 healthcare professionals across focus groups to gather a diverse range of views on the prototypes which had been developed.

6.2.1.2 Participant recruitment

Patient participants were recruited through the Patient, Carer and Public Involvement (PCPI) network hosted at the University of Sunderland. This network is a collection of people who are involved in the delivery of healthcare teaching and research in the Faculty of Health Sciences and Wellbeing. To support recruitment, an invitation letter (Appendix 6) and participant information sheet (Appendix 7) were developed and sent via email to those within the PCPI network alongside a consent form (Appendix 8). The focus group dates were

established prior to recruitment and included in the communication. Those participants that wished to take part contacted GD directly. Informed consent was taken either in advance of the focus group or at the start and re-confirmed verbally before data collection.

Community pharmacist participants were recruited through Local Pharmaceutical Committees. General practice professionals were recruited via email communication using professional networks. Potential participants were also identified through Academic Tutor contacts at the University of Sunderland and my own personal contacts. Dates for two focus groups were initially pre-arranged and advertised as part of the recruitment communication. One of these was an evening time slot, and another was arranged during the day to coincide with a Sunderland citywide training event for GPs and practice nurses called a Time In Time Out.

Email communication included an invitation letter (Appendix 9), participant information sheet (Appendix 10) and consent form (Appendix 11). Interested potential participants were asked to complete the consent form, which was either completed in advance and returned to me prior to the focus groups or completed just before the focus group started. Consent was re-confirmed verbally prior to data collection.

Following the arrangement and data collection of the four focus groups however, I identified a lack of GP feedback. Consequently, a fifth focus group was arranged. To recruit GPs specifically, a focus group was arranged to coincide with a specific GP practice training meeting. As for the previous groups, participants were told when and where the focus group would happen, and were provided with the same invitation letter, participant information sheet and consent form. Consent forms were completed immediately prior to the focus group and consent was re-confirmed verbally prior to data collection.

6.2.2 Focus groups

The focus groups were based around the six prototypes and were structured in a similar way. One prototype at a time was presented to the group. The group was then asked to study (for paper based) or watch (for the videos) the prototype before providing feedback on elements which they liked about the idea based on the prototype and things that they felt should be changed.

6.2.2.1 Focus group data collection

Each participant was provided with a data collection sheet to capture the aspects that they liked and their ideas for change as part of the process of silent generation of ideas as part the NGT framework. An example form provided is provided in Appendix 12. Once participants had finished studying or watching the prototype, the facilitator asked participants to share their thoughts and a discussion was facilitated. This was repeated for all prototypes within each of the focus groups. Topic guides for these focus groups are available in Appendix 13 and Appendix 14. The focus groups were audio recorded and transcribed verbatim. A second researcher (NH) also attended the focus groups and took additional notes on the focus groups.

6.2.2.2 Focus group data analysis

Following the focus groups, the data collection sheets and transcripts for all focus groups underwent analysis using Framework[290]. Framework analysis involves the construction of an analytic framework which is used to code the qualitative data and can be used in both an inductive and deductive way. For this study, the analytic framework was created initially using a deductive approach, by coding feedback comments against each of the prototypes which were discussed in the focus group, and within this also coding whether the comments represented positive feedback about the prototype, or a suggested change for the design. Within these categories, codes were then created inductively for specific comments in the

data. Initial codes for the analytic framework were created based on the data collection sheets which were populated during the silent generation of ideas section of the focus group for each prototype. These codes were then applied to the focus group transcripts deductively. Codes were refined where additional information or context was provided from the transcript data. Any remaining data outside of this analytic framework was coded inductively and aggregated into themes. The codes which were generated as part of the analytic framework then became the statements for the ranking exercise as part of the NGT process.

The initial expectation was that the analytic framework could be based around the prototypes and that these would lead to the generation of ranking statements for the same type of group (patients or healthcare professionals) that generated the ideas. However, some of the codes generated were related to a prototype not under discussion by that group. For example, healthcare professionals were also able to comment on the personalisation questionnaire questions as part of the 'principles for intervention personalisation document' as the questionnaire items were also presented in that prototype. These comments related to potential patient views on completing the personalisation questionnaire, so these were added to the ranking statements for patients. This allowed feedback from each of the different groups to be compiled and presented in the questionnaire for the subsequent ranking process as part of the NGT. This qualitative analysis was facilitated by nVivo 11[224].

6.2.3 Ranking questionnaire

The ranking as part of the NGT process in this study was conducted via self-administered online questionnaires, one for patient participants (Appendix 17) and one for healthcare professionals (Appendix 18). Each questionnaire was made up of statements generated from the qualitative analysis which were transcribed into the web-based software tool Qualtrics[291]. The questionnaires were organised by prototype, with each prototype made available to the participant again using links to an online file repository to support the ranking

exercise. Participants only ranked the statements relating to the prototypes that they had evaluated in the corresponding focus group type that they had participated in (either patient or healthcare professional).

6.2.3.1 Ranking questionnaire data collection

An invitation to complete the questionnaire and link was emailed to all participants who took part in the focus groups (available in Appendix 19 and Appendix 20). Questionnaire completion was tracked so that the response rate for the different participant types was available for subsequent analysis. Two reminders were sent to participants, one a week before the deadline and one just after the deadline was passed to those who had not yet completed the questionnaire at those points. Validation was included within the online questionnaire to ensure that 5 different statements were given a rank. One participant requested a paper-based questionnaire, this replicated the online version but with URLs provided to the online prototype content. This was returned using a pre-paid self-addressed envelope but was discarded from the analysis, as the ranking instructions had not been followed.

For each of the prototypes, statements generated from focus group analysis for aspects that participants liked were presented. Participants were then asked to rank five of the statements that they felt were most important from one (most important) to five (least important). The total number of available statements in which to select varied by prototype (see questionnaires in Appendix 17 and Appendix 18). This was then repeated for the suggested changes for the same prototype, before moving on to the next prototype. The decision to ask participants to rank just the top 5 items was based on other research which has found this is a more manageable number for participants to complete[292].

6.2.3.2 Ranking questionnaire data analysis

In NGT[288], the rank for each statement allocated by participants is converted into a weighted score. The more highly a statement is ranked, the higher the score that is allocated. This generation of scores is done at the participant level. For example, a rank of 1 which represented the most important statement from the given options was given a score of 5, 2 a score of 4 etc. Once the ranks have been converted to a score at the individual participant level, the scores can be added together for the whole participant group to indicate the most important aspects of the concept design to keep and the most important aspects to change.

For clarity, all participants' ranks were considered equally with no adjustments. So, for the video of the pharmacist consultation prototype, which was used across all five focus groups, each participant contributed equally to the overall score. As there were more healthcare professional participants compared to patient participants in this calculation, this does mean that the healthcare professionals' scores contribute more to the overall scores. However, in the results section, scores have been separated out so each group of participants can be seen.

6.2.4 Ethics and governance approvals

The study was approved by London Riverside Research Ethics Committee (REC Reference 18/LO/1201) and the University of Sunderland Research Ethics Committee (Reference number 002718). This study was also approved from a governance perspective by the Health Research Authority (IRAS ID: 238875). Approval letters can be found in Appendix 15 and Appendix 16. Patient participants at focus groups were provided with a £20 gift voucher as a thank you for their contribution to the study. No incentives were provided to professional participants, though all focus groups were catered.

6.3 Results of the intervention concept feedback with patients and healthcare professionals

Five focus groups took place between 2nd October and 14th November 2018. Nine patients participated across two focus groups and 21 healthcare professionals took part across three focus groups. Healthcare professional participants included pharmacists (n=7), practice nurses (n=5) and GPs (n=9). The first four focus groups lasted an average of 1 hour 28 minutes; the fifth focus group was conducted in 59 minutes to match the normal length of the meeting which the focus group replaced and so the average across the five focus groups was 1 hour 21 minutes.

Following the qualitative analysis, statements that described the aspects that participants liked about the intervention concept and ideas for change based on the prototypes presented were transferred into the ranking questionnaire. Eleven healthcare professional participants (52% response rate) and six of the patient participants (67% response rate) then completed the ranking questionnaire providing an overall response rate of 57%. Ranks were calculated and ordered from high to low, with the focus being on the three highest ranked likes and changes for each prototype.

The following results are organized by prototype, starting with the qualitative analysis, and followed by the statements which were generated alongside the results of the ranking exercise as part of the modified NGT. The statements which were ultimately incorporated into the re-iterated design for the delivery co-design studies (see Chapter 7, Chapter 8 and Chapter 9) are also shown in each of the corresponding results tables for each prototype.

6.3.1 Video of pharmacy assistant inviting patients to the intervention

The feedback from patient participants on the video prototype demonstrating how patients might be invited to receive the TIMELY intervention was generally positive. Patients liked the

informal approach and that the conversation seemed to be based around an existing relationship between the pharmacy assistant and the patient. The patients also liked that there was no requirement for the patient to be identified as non-adherent to their medicines. There was some disagreement in the qualitative data however, around what information was required at this point of invitation to assess the appropriateness of the intervention for the patient.

Table 11 Summary of responses to the ranking questionnaire for the video of pharmacy assistant inviting patients to the intervention

Like statements	**Total ranked score**	**Kept for next version?**
Right information given to allow the patient to make a decision	17	Yes
The informal approach	16	Yes
No pressure was put on the patient to sign up	15	Yes
The introduction was very general, not targeted at a specific patient based on a judgment of their previous compliance	13	Yes
There was an open amount of time given to complete the questionnaire	12	Yes
That it was built on an existing relationship between the patient and the pharmacy assistant	11	Yes
Change statements	**Total ranked score**	**Changed for next version?**
Patient should be offered help to complete the questionnaire if they need it	28	Yes
The patient information leaflet should be offered before the patient is asked to complete the questionnaire	19	Yes
Patient should be offered the option to complete the questionnaire in the consultation room or at home and bring in later	16	Yes
Communication should be at the same level (e.g. both sitting down or both standing)	15	Yes
The pharmacy assistant should ask the patient if they have a mobile phone before introducing them to the service	13	No
There needs to be a way of offering the service to patients who may have medicines delivered or who are housebound	11	Yes
Pharmacists should also offer the service if issues are identified as part of a medication review	5	No

There were also suggestions from patients that some alternative options for filling in the personalisation questionnaire should be offered following the invitation, such as completing the questionnaire in the consultation room, potentially with the support of a pharmacy staff member or taking the questionnaire away to complete and return at a later point. Patient participants also asked if the intervention could be introduced to patients receiving deliveries for their medication from the pharmacy.

The statements generated from the qualitative analysis, alongside the ranking scores can be found in Table 11. The highest ranked statement for change was to make sure that patients are offered help to complete the personalisation questionnaire once they have expressed an initial interest in receiving the intervention. Offering the patient information leaflet (as tested in another prototype) was next highest in terms of change to the invitation to receive the intervention. Ranked third was allowing patients to complete the personalisation questionnaire at home or in the consultation room. All the aspects patients liked and most of the suggested changes were made for the next version of the TIMELY intervention which underwent 'live' prototyping.

6.3.2 Personalisation Questionnaire

Following completion of the personalisation questionnaire in the focus groups, patients felt that the form was clear and easy to fill out. Some patients reported that the use of tick boxes made it easy to complete. Patients felt that answering the questions would provide a good indication of how they perceived their medicines. One change suggested by patients included adding in a question about who looks after the phone bill, as some older people may have this managed by their sons/ daughters. In the focus group, patients requested more information about how the responses would be used to decide the text messages.

After further information was provided about how the TIMELY intervention might work (based on the suggestions in the principles for intervention personalisation document prototype),

patients felt that they should be able to choose whether or not they receive reminder text messages, rather than this be decided by an algorithm.

"…because of the way I've answered the questionnaire I won't get a reminder."
Patient, Focus Group 3

The initial questionnaire also asked patients to self-identify which long-term conditions they had, with tick boxes for the long-term conditions which were suggested to be part of the intervention. Some patients felt that this should be something that the pharmacist should ask, rather than being included in the patient questionnaire.

When evaluating the personalisation of intervention principles prototype, pharmacists in one of the focus groups suggested the removal of the 'neither agree nor disagree' option in the responses to the questionnaire. Although this was not raised by patients, it was included in the questionnaire statements for this prototype as well as in the principles for intervention personalisation document.

These qualitative comments captured during the focus groups around the personalisation questionnaire were further reinforced in the ranking exercise for the statements of what patient participants liked (see Table 12). A clear change requested was the addition of a question to ask about reminder preferences for patients and this was included for the next version of the intervention.

Participants also voted to remove the 'neither agree nor disagree' option from the personalisation questionnaire responses. However, as the 5-point Likert scale comes from the validated BMQ and A-SRHI tools, modifying these responses could compromise questionnaire validity, so this was not changed for the live prototyping study with patients. The third highest ranked statement to add in a space for the patients' mobile phone number to be collected was included in the next iteration of the personalisation questionnaire.

Table 12 Summary of responses to the ranking questionnaire for the personalisation questionnaire

Like statements	**Total ranked score**	**Kept for next version?**
Easy to read and understand	22	Yes
Clear layout	22	Yes
Use of tick boxes for most of the questions	21	Yes
Questions did''t feel too intrusive	17	Yes
Felt that my responses would identify any problems to address	2	Yes
Change statements	**Total ranked score**	**Changed for next version?**
Ask whether medication reminders is something the patient would benefit from	18	Yes
Remove''neither agree nor disagre'' option in the questionnaire responses so that people have to answer positively or negatively	15	No
Add in a space for the phone number to be given	14	Yes
Add a question asking if the patient has regular carers	12	No
Pharmacist completes long-term conditions, liaising with the GP surgery instead of the patient completing this on the form	11	Yes
Add an additional statement in the questionnaire about medicines taking routine (e.g. I have a routine for taking my medicines)	11	No
Add in a question to ask about who looks after the phone contract (e.g. son / daughter)	9	Yes
Ask whether people would like information about text to voice functions available on their phone	0	No

6.3.3 Patient Information Leaflet

The patient information leaflet designed to provide information about the intervention was also generally well received by patients. There was some discussion about whether some of the language was a bit too informal for materials to be provided from a professional pharmacy environment.

"I think we should be saying hello not hi, because older people certainly don't say hi. It annoys them, they want to say hello it's Flo here."

Patient, Focus Group 3

Table 13 Summary of responses to the ranking questionnaire for the patient information leaflet

Like statements	**Total ranked score**	**Kept for next version?**
Easy to read and understand	29	Yes
Clear layout	21	Yes
Real examples of text messages the patient might receive	18	Yes
Covered most of the information the patient would need	14	Yes
Comments from other people who have used the service	8	Yes
Change statements	**Total ranked score**	**Changed for next version?**
Add information on how long it will take Flo to respond	27	Yes
Include information on what happens if patient uses a error (e.g. typo) in the message	26	Yes
Use real photos rather than graphics (e.g. ClipArt)	23	Yes
Add space for a pharmacy stamp with name and contact details	20	Yes
Add in information about NHS 111	19	No
Include more general message examples (e.g. not specific to high blood pressure)	17	No
Make emergency information more prominent	15	Yes
Change references to“"SM”" to“"text messag”"	6	Yes
Change“"Flo says hell”" to something more formal	0	No

Other suggestions included changing the use of SMS to “text message”, adding in information about NHS 111, allowing space for information about the pharmacy, making emergency information more prominent and more information on what to expect when interacting with the intervention.

The statements which were included in the ranking exercise for the patient information and the results of this can be found in Table 13. These reinforced elements that patients liked about the prototype captured from the qualitative data. The highest ranked change was to add information about how long it would take the text messaging system to respond to replies from patients, followed by providing information on what would happen if a patient

made an error in a reply. These changes were made in the next version of the patient information leaflet.

A request to use photos rather than ClipArt ranked third in the items to change and so this was altered for the live prototyping study. Changing the tone of the messages scored 0, likely because the participant that raised this in the focus group did not complete the ranking questionnaire. All elements that participants liked were also kept for the subsequent version of the information leaflet.

6.3.4 Video of pharmacist consultation

The video prototype which demonstrated a proposed version of the consultation between a community pharmacist and a patient using an MUR was the only one with data from all five focus groups. There was positive feedback from most participants. It was agreed that the use of a medication review prior to a text messaging intervention was a good opportunity to detect any medication-related issues and ensure that the patient had a good understanding of their medication prior to receiving any messages.

> *"I really liked the MUR…I think having that conversation at the start is really good"*
> *Pharmacist, Focus Group 1*

There were also suggestions that a medicines review could be an opportunity to provide the intervention to patients. However, the potential time pressure of the review was highlighted as a potential barrier to delivering the intervention. Patients also enquired whether the consultation could take place in someone's home to reach patients who may be unable to access the pharmacy.

There was agreement that setting up the patient with the text messaging system, including the requirement for them to respond to a text message in the consultation itself was a good idea. But there was also a range of additional verbal information was requested for inclusion

by patients and professionals to further support use of the text messaging intervention. This included use of home monitoring equipment and reinforcement that the 'Flo' persona was not a real person.

> *"I don't know if you made it clear enough, but I think it's really important to make it clear that it's automated. Although it's got a name, it is automated so it's not going to be a hundred percent perfect. If it seems to be giving them a message that doesn't quite make sense or is concerning to them, then tell them who to contact."*
>
> *General Practitioner, Focus Group 5*

There was also some debate about how formal the consent process needed to be. The pharmacists in particular felt written consent was needed rather than the verbal consent process which was demonstrated in the video.

> *"I think a lot of patients are concerned about data protection; GDPR regulations etc. and most of them have to sign consent forms for everything."*
>
> *Pharmacist, Focus Group 1*

There was also a question about whether medication adherence should be directly established as part of the intervention. Patients did not think it should be a pre-requisite for offering the intervention and felt that it should not be included in the questionnaire, however there was some debate about whether it should be considered as part of the consultation. Some participants also highlighted the limitations of this question and that patients may not reveal nonadherence, rendering asking the question of little use.

The statements which were generated from the qualitative analysis and the ranking results for the aspects that participants liked can be found in Table 14 and the suggested changes in Table 15. The ranking revealed good consensus for using a medication review as part of the intervention. Participants also agreed that the consultation needed a clear explanation of how the text messaging intervention would work, and that the consultation should be face-to face. The idea that patients should be able to choose the timing of messages as part of the intervention was valued by all participants.

Table 14 Summary of like statements and responses to the ranking questionnaire for the video of the pharmacist consultation

Like statements	Professionals' Rank Score	Patients' Rank Score	Total Rank Score	Kept for next version?
A clear explanation of the service being offered	36	17	53	Yes
Using a face-to-face method of communication	25	19	44	Yes
Ability of patients to choose the times messages were sent	22	5	27	Yes
Including a medication review as part of the set-up	18	9	27	Yes
Checking if the patient is experiencing any side effects from medication	10	9	19	Yes
Clear communication that the patient can opt out of receiving messages at any time	7	8	15	Yes
Providing a patient information leaflet	7	6	13	Yes
The opportunity to address adherence problems not covered by text messages	10	2	12	Yes
The use of Flo as a persona to communicate with	9	3	12	Yes
Taking place in a private consultation room	7	5	12	Yes
Explanation about the costs of participating to the patient	1	7	8	Yes
Setting up the service with a message in the consultation	7	0	7	Yes
Use of home monitoring equipment and sending in readings	6	0	6	Yes

Table 15 Summary of change statements and responses to the ranking questionnaire for the video of the pharmacist consultation

Change statements	Professionals' Rank Score	Patients' Rank Score	Total Rank Score	Changed for next version?
Add in a more formal written consent process (e.g. sign a consent form)	24	7	31	No
Make sure that timing of medication taking is captured and checked	17	14	31	Yes
Check patient knows how to correctly use home monitoring equipment in the consultation before use (e.g. peak flow meter)	22	7	29	Yes
Include a verbal explanation that Flo is''t a real person	13	15	28	Yes
Cover data protection and regulation in the verbal consent process	18	6	24	No
Talk about the expected benefits of using text messages to support medicines taking	12	8	20	No
Option for consultation to be done in patient'' home	11	9	20	No
Ensure that home blood pressure monitoring equipment is accurate (calibrated) prior to use	13	4	17	No
Confirm long-term conditions as part of the consultation	2	13	15	Yes
Add a question to assess adherence (e.g. how many doses have you missed in the last 7 days)	9	4	13	No
Add in verbal instructions on how to cancel text messages	5	3	8	No
Provide an estimation of how many text messages the patient is likely to receive	8	0	8	No

The highest-ranking statement for change amongst participants was to make sure that the verbal explanation that 'Flo' wasn't a real person was strengthened and this was included in the live prototyping consultation in the subsequent stage. Both professionals and patients also agreed that it was important to capture and check medication timing and so this was also included in the consultation for the future simulation study.

A change to confirm patients' long-term conditions in the consultation was the third most important change for patient participants and resulted in a change to the personalisation questionnaire to move the long-term condition question to the pharmacist section of the questionnaire. Interestingly, the suggested change to include a question to assess medication adherence as part of the pharmacist consultation ultimately came out as low priority in the ranking exercise and was therefore not taken forward.

A suggestion from patients to potentially conduct the pharmacist consultation in patients' homes was ranked highly by pharmacist participants but was not ranked at all by practice nurses or GPs.

Including an explanation about the expected benefits of the text messages was ranked as the most important change by nurse participants. However, as the intervention is still untested at this point it would be difficult to include this beyond the reference to 'improving motivation' which already appeared in the introduction to the intervention. However as this was not a prototype which the healthcare professional participants were exposed to, keeping this element may meet this criterion rather than adding this information to the pharmacist consultation itself.

The suggestion to add in a more formal written consent process to the pharmacist consultation for the intervention was not incorporated into the live prototyping phase. The prototypes developed for this study were designed to represent what the delivery of the

intervention might look like if it were incorporated as part of a commissioned service. At the time of data collection, written consent was commonplace as part of the delivery of community pharmacy services. A verbal consent model for the prototypes in this initial design concept was chosen to mirror how Florence was used in the general practice setting. The results of the ranking found that community pharmacists did not seem to be comfortable with this.

6.3.5 Principles for intervention personalisation document

The principles for the intervention personalisation document suggested how responses to the questionnaire sections could link to intervention content. These ideas were generally well received, healthcare professional participants liked that the content was tailored to patients' beliefs about their medication and the consideration of habit in medication-taking. Participants felt that the inclusion of medication reminders in the intervention was a valuable component and liked that the BCTs for feedback and monitoring of medication-taking allowed for 'imperfect' adherence.

> *"I like that they set their own target, if we're saying take your statin every day, but they only want to take it four nights a week, well that's their target"*
>
> *General Practitioner, Focus Group 5*

Participants were also supportive of the overall concept, with messages designed to support self-care and patient activation aligned to the Simple Telehealth philosophy.

> *"It puts the buck on them in a way that they're going to have to be more responsible and I quite like that."*
>
> *Practice Nurse, Focus Group 4*

However, some of the example text messages included in the prototype were felt to be potentially inappropriate for some patients, especially those linked to the more extreme consequences of uncontrolled disease, including a suggested message about risk of amputation and potential costs associated as a consequence of uncontrolled diabetes.

"Although they are good in some respects, I think some of them would frighten the patient. The one about the diabetes, if you don't [take your] medication you might have an amputation, that would put the fear of god into a lot of people and they would be on the phone."

Practice Nurse, Focus Group 4

The other main suggested change was the rewording of the message designed to deliver the behaviour experimentation BCT suggesting that patients stop their medication to see what effect this has.

"If you're getting side-effects, maybe stopping it [their medication] might be helpful, but you might be on it for an important reason. If it was antiplatelet [medication] after a stent, you wouldn't want them to stop it without talking to you first."

General Practitioner, Focus Group 5

The full list of statements which were generated from the qualitative analysis and the results of the ranking exercise can be found in Table 16 for the prototype which outlined the principles for the personalisation of the TIMELY intervention. The highest ranked statement for aspects that healthcare professional participants liked was the emphasis on self-care. The suggested tailoring process for the intervention concept was also ranked as important, alongside the acknowledgement of 'imperfect' adherence as part of the intervention.

The188iscomfortrt that professional participants felt with some of the BCTs resulted in the highest ranked statement being for a suggestion to create 'layers' of messages. This potential to create layers of different message types, with more controversial messages reserved for patients who continue to be non-adherent, was something which was difficult to decide on. There was a discussion of these results at a steering committee meeting. It was felt that patients might be a better judge of whether these messages were inappropriate or not and therefore, these messages were retained with a view to testing these as part of the live prototyping study with patients.

Table 16 Summary of responses to the ranking questionnaire for the principles for intervention personalisation document

Like statements	Total ranked score	Kept for next version?
The patient self care emphasis which encourages patients to take responsibility	33	Yes
The tailoring of content to individual patients	30	Yes
Realistic targets which allow‘'imperfec’' adherence	20	Yes
Providing information in smaller‘'chunk’' which may be easier for the patient to digest	17	Yes
The simple language used in the messages	16	Yes
The inclusion of prompts / cues to support medicines taking	14	Yes
Messages tailored to patient'' beliefs about medication	14	Yes
Messages encouraging patients to get feedback on medicines taking (e.g. blood pressure)	8	Yes
Two way communication between the patient and Flo	7	Yes
Prioritisation of concerns, then necessity, then experience, then habit.	4	Yes
That the intervention is automated	1	Yes
The use of habit as a model for the messages	1	Yes
Change statements	**Total ranked score**	**Changed for next version?**
Create layers of messages, with more dramatic messages (e.g. amputation being reserved for those with persistent nonadherence)	30	No
Re-word the behaviour experimentation message to seek approval from a healthcare professional before stopping medication to notice any impact	29	Yes
Provide home monitoring devices (e.g. blood pressure monitor where messages are indicated but patients do not have the equipment)	23	No
Add an additional statement in the questionnaire about medicines taking routine (e.g. I have a routine for taking my medicines)	22	No
Remove‘'neither agree nor disagre'' option in the questionnaire responses so that people have to answer positively or negatively	21	No
Add in side effect monitoring as part of the intervention	17	No
Remove requirement to input keywords in responses such as“'MED”' or“'DAY”'	10	No

Professionals also felt that the behaviour experimentation BCT message should require discussion with a healthcare professional. Rather than being re-worded, this was removed in the live prototyping study because although it was behaviourally sound, the clinical implications presented an unnecessary risk to patients' health.

The suggestion that home monitoring devices should be provided if BCTs around outcomes of medicines-taking behaviour were important also made it to the top three ranked statements. As there was no budget for this, home monitoring devices were not provided for the purpose of the subsequent live prototyping study (see Chapter 7), but it was explored in that study.

6.3.6 Flow diagram of integration pathway

Feedback on the integration pathway was generally positive. Healthcare professionals liked that the information was shared with other professionals providing care to the patient and agreed that a website would work as a portal for information about the intervention. Most healthcare professional participants liked that the intervention was pharmacy led, although some participants from general practice were sceptical about whether they knew their patients better than the pharmacists. This also led to the suggestion that if home blood pressure monitoring was used, patients' targets should be confirmed with the GP practice in advance.

> *"We might have more of an idea about the patient than the pharmacist. We tend to see the same patients regularly, so you get to know those patients properly."*
> *Practice Nurse, Focus Group 4*

When exploring whether practices should be automatically notified that patients were receiving the intervention, there seemed to be consensus in the focus group data that an automatic notification would be useful.

"If it came on the medications screen saying in Flo and whatever messages they're getting, so we know which pharmacy they're matched to and things like that. If it was on there then at least we know, we've got that information, and then if the patient does come to you, you know what it's all about."

Practice Nurse, Focus Group 4

One suggested change included restricting intervention provision to patients' nominated pharmacy only, where their prescriptions are normally sent as this was easily identifiable to practices. GP Practice staff also suggested not sending messages over the weekend, as they would not be open to support any queries arising from text messages.

Pharmacists felt that the suggested model made good use of the wider pharmacy team and supported the use of PharmOutcomes for record keeping. To ensure that the text messages patients received seemed to be appropriate, a follow-up call to patients after receiving the intervention for a short period was suggested as a safety procedure to add into the pathway.

The statements from the qualitative analysis relating to the flow diagram of the intervention pathway, and the results of the ranking exercise can be found in Table 17. There was good agreement across the different healthcare professional participants that the intervention being pharmacy led was desirable. The idea that participants liked the data sharing model that the Simple Telehealth system offered was further reinforced with a high-ranking score. The process described in the prototype also ranked highly for being clear and making sense. Pharmacists also liked the use of PharmOutcomes as part of the flow diagram, although this did not score highly with the GPs practice nurse participants. This may be due to their lack of familiarity with this platform.

Table 17 Summary of responses to the ranking questionnaire for the flow diagram of the integration pathway

Like statements	Total ranked score	Kept for next version?
Community pharmacy led service	41	Yes
That data is accessible to all healthcare professionals	40	Yes
Process is clear and makes sense	33	Yes
Makes good use of pharmacy support staff	20	Yes
Use of PharmOutcomes (a software platform for community pharmacy teams)	16	Yes
A website can act as a portal for more detailed information about specific content where needed	15	Yes
Change statements	**Total ranked score**	**Changed for next version?**
Confirm individual monitoring targets for patients with GP practice prior to using home monitoring (e.g. blood pressure targets for patients using home blood pressure monitoring)	28	No
GP practices should add notification of patient using Flo to GP record, to ensure any medication changes are communicated to the pharmacy	23	Yes
Community pharmacies should contact the GP practice on behalf of patients initially where queries arise	22	Yes
Notification to practices should include which protocols have been set up for patients.	20	Yes
General practice should receive notification of set up for information only	17	Yes
Add in a message to ask if the patient is happy with the messages so far shortly after initiation of intervention	17	Yes
The nominated pharmacy should be the only one able to provide the service	16	Yes
Messages should only be sent Monday to Thursday to allow quick access to healthcare professionals where there are queries	13	Yes

The highest ranked change for the flow diagram was to add in a step for pharmacists to confirm monitoring targets with GP practices. This was discussed amongst the supervisory team and at a steering committee meeting. Although the Simple Telehealth software allows for this level of personalisation, it was felt that this makes the intervention a lot less streamlined. It was decided to retain standardised targets for the live prototyping version of

the intervention but explore this with patients. All other suggested changes were made for future iterations of the TIMELY intervention.

6.3.7 Additional themes from the qualitative analysis

In addition to comments about the prototypes themselves, there was also data relating to some additional themes in the qualitative analysis which didn't translate into statements in the ranking exercise. These themes were:

- Governance associated with the TIMELY intervention
- Linking TIMELY to other technologies
- Operationalisation of the TIMELY intervention

6.3.7.1 Governance associated with the TIMELY intervention

There were concerns from pharmacists in the focus groups about who would take responsibility for the content of the messages, setting up the messages and also ensuring that the messages were still relevant for the individual patient.

> *"I think I would like to have more information about exactly what messages are sent for the different settings, because with some of those you're setting up with it and they might receive a message that you don't agree with, that you think shouldn't have been sent."*
>
> *Pharmacist, Focus Group 1*

Patients were also concerned about how information received into the pharmacy would be handled including whether there was a risk of the system being misused.

> *"Patients may misuse it and might text help I'm having a heart attack, you just don't know. So I'm a bit concerned about the whole area of responsibility here."*
>
> *Patient, Focus Group 3*

There wasn't a clear consensus in the qualitative data on how text message content would be reviewed by pharmacists delivering the intervention, and from my perspective how that might affect the validity of the intervention itself if pharmacists were able to remove

messages from the library, therefore potentially removing mechanisms from the intervention. Exploring the acceptability of the text message library may be beneficial prior to mobilising the TIMELY intervention.

There were also suggestions that pharmacists could complete some sort of retrospective audit to check that the right messages were being sent according to the personalisation questionnaire, and that details like mobile phone number were up to date.

> *"From the pharmacy side I wonder if you could audit [use of the intervention]. I think it would come down to training of whoever is actually inputting because human errors happen."*
>
> *Pharmacist, Focus Group 4*

6.3.7.2 Linking TIMELY to other technologies

Suggestions to further enhance the intervention included linking it to smart devices which were identified as being increasingly prevalent.

> *"I was thinking it would be a good idea to have response made with technology, because there are things that people could wear, instead of listening for a phone."*
>
> *Patient, Focus Group 3*

6.3.7.3 Operationalisation of the TIMELY intervention

There was some discussion in the community pharmacy focus group about how the TIMELY intervention might work in practice, and some potential issues with operationalisation of the intervention. These included the role of locum pharmacists, funding and recruiting patients to receive the intervention.

> *"I think maybe a setup fee, and it doesn't necessarily have to be a lot. But obviously you're allocating staff time to do this alongside other things that we're asking them to do like find an NMS, identifying MUR, and flu jabs. So will they prioritise doing those things that there is a fee attached to over [other activities]."*
>
> *Pharmacist, Focus Group 1*

6.4 Discussion of findings from feedback on the new intervention concept

The objective of this study was to co-design an initial design concept for a new intervention which combines a community pharmacist consultation with automated two-way text messaging to support medication adherence. The results have shown that the initial concept is acceptable to patients, general practice and community pharmacists at the conceptual level. The process of gaining feedback has also identified some useful ideas for changes. The strengths and limitations of this study will now be discussed before considering how these findings were used to support the re-iteration of the design for the following studies with patients (see Chapter 7), community pharmacy (see Chapter 8) and general practice (see Chapter 9).

6.4.1 Strengths and limitations of the focus groups with modified NGT

The use of focus groups had initially been designed to prompt discussion, especially amongst healthcare professionals. However, the timing of the focus groups meant that it was difficult to gather a mixture of healthcare professionals from different settings. The evening focus group (Focus Group 1) contained only pharmacists, the session at the Time In Time Out session was dominated by practice nurses, and the additional focus group (Focus Group 5), was multidisciplinary but based at a single general practice. Combined, the focus groups seem to offer a good range of feedback on the initial design concept for the new intervention but may have benefited from a more multidisciplinary and cross-organisation discussion.

It was also encouraging that the patient participants felt very comfortable with the delivery of this intervention from a community pharmacy setting. Many of the participants would have worked closely with pharmacy students as part of the role within the University and so this is perhaps unsurprising but was still a good indicator that the concept could be acceptable to others.

The setting for this study was the North East, however all data collection took place in Sunderland. Whilst contracts for community pharmacies and general practice are consistent nationally, there may be contextual factors specific to this area, such as patient demographics or local commissioning arrangements which may have affected the feedback provided. However, as the design process was iterative, there would be further opportunities to collect feedback. Many developmental studies are developed within a local area due to the practicalities of accessing a participant population, especially when using focus groups and so at this point in the development process this is less of a limitation.

The generation of statements from qualitative analysis of focus groups for a NGT exercise has been done by others[293] but as part of a re-ranking exercise to combine initial statements across multiple NGT groups rather than the only ranking exercise. This does have some effect on the robustness of the method. In a normal NGT setting, participants would group the statements from the initial gathering of ideas and write the final versions themselves with the help of the facilitator. This removes ambiguity from the final statements which are then subject to the ranking exercise. Generating the change statements from a qualitative analysis means that some judgements were made about which ideas from individuals across the five focus groups were similar. These were then translated into the statements for ranking in the questionnaire without additional input from participants. As this was part of a qualitative analysis process, the statements were grounded in the wording of participants. If this step in the process was not completed, ranking scores in the questionnaire would have been diluted across multiple similar statements with potentially important aspects or changes then not being prioritised in the final ranked score.

Moving the ranking to an online questionnaire following the focus groups also resulted in reduced participation in the ranking. Only 57% of respondents who participated in the focus groups also participated in the ranking exercise, however this is similar to the percentage of valid responses received in the study by Hutchings et al.[293] (55%) who also conducted a

ranking exercise following group discussion using NGT. This could reflect a reduced motivation of participants to contribute to a ranking exercise when they have already contributed their views in the qualitative stage. Whilst reminders were used to increase response rate, this reduction is a limitation of the ranking exercise. The benefit of using the online questionnaire based on qualitative analysis across all focus groups was being able to prioritise statements across both the patient and healthcare professional participants however there was uneven representation in the response rate with more pharmacists completing the questionnaire (86%) compared to practice nurses (40%) and GPs (33%) although this may be reflective that the pharmacist participants are more invested in the development of a new pharmacy service than general practice participants.

Prototypes were combined with focus group including a modified version of NGT to accommodate potentially conflicting feedback. If there had been diverging opinions, the ranking exercise would have supported decisions about which changes were higher priority across all participants. However, as there was little disagreement amongst participants, this element of data collection only slightly added to the qualitative data analysis. However, including both patient and healthcare professional participant feedback across the same prototype, as done with the pharmacist consultation reduced potential for conflict later in the intervention development as discrepancies in feedback would not be picked up until feasibility testing of the final intervention.

6.4.2 Translating the findings into the next version of the TIMELY intervention

All the suggested changes from this study were considered for action in the work package which would further develop the new intervention. Most of the changes ranked in the top three for all the prototypes were incorporated with only some exceptions. Some changes which did not necessarily make the top three in terms of ranking were also incorporated into the new iteration of the design if they were easy to incorporate or the idea was a logical adjustment to support the delivery of the intervention.

The prototype for selection of intervention components based on the personalisation score used raw scores from each of the subscales within the BMQ. However, a meta-analysis study found that necessity-concerns differential was a better predictor of medication adherence[36]. The study also highlighted that higher concerns scores can be balanced out by higher necessity scores. Therefore, delivering messages to simultaneously reduce concerns and improve perceived necessity may offer a better strategy than providing just one of these. Selection of the text message protocol using the necessity-concerns differential rather than the raw scores may also increase the feeling of message relevance to participants. Therefore, this alternative approach to selecting text message protocols was used for the co-design of intervention delivery with patients study described in the following chapter.

6.4.3 Areas for further investigation

The findings from this study also identified areas which required further investigation in subsequent studies. Feedback from patient participants highlighted the importance of pharmacist training to ensure that the consultation was optimised to build rapport between the patient and the pharmacist. Following this study, the government announced the decommissioning of MURs from community pharmacies in the NHS[65]. Whilst this meant that the pharmacist consultation was no longer constrained by the service specification for a MUR, it would mean that a new consultation format would need to be designed for use in conjunction with the automated two-way text messages. This is explored in the following chapter.

This study added confidence that an automated two-way text messaging intervention could be used in the context of multimorbidity. However, the approach outlined at this concept stage would be something which required further investigation. This would include the design of text message content and its delivery and considering the constraints of the

technological capabilities of the Simple Telehealth software. The development of the text message library is described in the next chapter.

There were also issues raised in this study surrounding the operationalisation of the new intervention in the community pharmacy setting. This included preparation for intervention delivery, some of which is explored in Chapter 8. However, funding arrangements for the new intervention still require investigation in a future evaluation.

Overall, the breadth of feedback and the actionability of the feedback captured in this study suggests that it was successful at assessing the initial acceptability of the newly designed TIMELY intervention. However, this approach also allowed patients and healthcare professionals to feed into the design process and support the next iteration of the intervention design.

Chapter 7 Co-design of intervention delivery with patients

This chapter builds on the development of the new TIMELY intervention concept which was described in Chapter 6. The aim of the study in this chapter was to explore how the intervention would be delivered with patients. The development of the text message library for the new intervention, building on the concept described in the previous chapter, is provided in the first part of this chapter. This is followed by a description of the updated prototypes to support intervention delivery with patients. Feedback was gathered on the intervention by delivering a 'live' simulation of the intervention and gathering feedback from patients. Methods for data collection and analysis of feedback are provided, followed by results and discussion. Subsequent chapters then describe other intervention delivery co-design studies with community pharmacy staff (Chapter 8) and general practice (Chapter 9).

Between the co-design of intervention concept study and the chapters exploring intervention delivery, the persona used for the TIMELY intervention switches from Florence to Alice. This was due to a change in version in the Simple Telehealth software (see Section 2.4.3). The announcement that Medicines Use Reviews (MURs) would be decommissioned by National Health Service (NHS) England also took place at this point[65]. Therefore, references to MURs used in the intervention concept study are replaced with an 'enablement' consultation which is further described in this chapter.

7.1 Developing the text message library

In Simple Telehealth terminology, a protocol is a collection of text messages, within which there are a series of 'Care Plans'. Care plans are the different text message types, and these include those which are one-way or two-way. The two-way message care plans are further defined by the anticipated message response format, for example whether the system asks for a numerical value or a word. This enables the appropriate algorithms to be constructed which allow the system to effectively 'read' and respond to the patients' replies.

A variety of text message types were created as part of the library depending on their intended function as part of the intervention. For example, one-way text messages were used for delivering the Behaviour Change Technique (BCT) 'Prompts/Cue's and two-way messages for monitoring taking medication and health outcomes.

Text messages were composed using the Simple Telehealth style[294]. This style encourages a friendly and conversational approach to text messages using a 'persona' so that patients feel as though they are communicating with a real person. The persona for the TIMELY intervention was 'Alice'. As such, text messages may be introduced or signed off using this name. The guidance from Simple Telehealth also encourages the use of "you" and "your" to maximise the personal feel of the intervention. It also emphasises the importance of avoiding technical language, incorporating variety into the messages where the same/ similar message is going to be repeated over a longer period and ensuring that the messages add value to the patient were also emphasised within the guidelines.

An Excel[226] spreadsheet was used to compose the messages so that the character length of each message can be tracked and highlighted if it exceeds the Short Message Service (SMS) limit of 160 characters. In addition, columns were added to the spreadsheet to categorise the messages for the long-term condition to which they were aimed, the protocol they were incorporated into, the BCT(s) the message intended to deliver and the source from which the message was inspired.

Initial drafts of the text messages included all the BCTs outlined in the co-design of intervention concept study (see Section 6.1.5). However, these messages had not considered the technical constraints of the Simple Telehealth software. For example, when starting to generate the text messages for the library and add these into the software, it became clear that an intervention tailored to specific medications was going to be overly complicated to deliver. Therefore, messages which referred to medicines could only be for

those that were common to a particular long-term condition, for example the use of inhaled corticosteroids for patients with asthma, but not a specific inhaler, such as Clenil. Therefore, messages which referenced a medicine which was not ubiquitous to that condition could not be included. This resulted in the removal of several messages from the co-design of intervention concept study prototype, for example the message that referred specifically to the dispersible formulation of paracetamol.

Support to develop the text message library was received from a Simple Telehealth Product Support Officer (STPSO). The STPSO had experience of working on Florence and was able to provide feedback on potential issues from text message examples included in the co-design of intervention concept study. This included the use of rhetorical questions. As the system can receive and respond to text messages, this creates the expectation that if Alice asks a question, a response is required. Using this functionality alongside one-way rhetorical questions could cause confusion for patients, especially as the system would respond with an error message. Therefore, questions such as “Hi, it’s Flo. How do you feel after you’ve taken your diabetes medication?” were not transposed into the text message library. Although text messages for the live simulation for patients would only last for two weeks, a library of messages for a full 12-week intervention period were created in preparation for a future feasibility study.

7.1.1 Text message delivery structure

The narrative synthesis systematic review had revealed that a high frequency of message delivery did not necessarily lead to improved outcomes. Indeed, studies with less frequent communication were found to be highly effective. Guidelines on the frequency of communication were also provided in the Simple Telehealth guidance, however the unique challenge for TIMELY was delivering the intervention in the context of multimorbidity. So, the text message delivery needed to balance between influencing behaviour without over-

burdening patients with text message content, especially if they had multiple long-term conditions within the intervention.

As there were no examples for delivering long-term specific text message content to patients with multiple long-term conditions, I had to design a new framework for text message content delivery in this context. When creating text message protocols in the Simple Telehealth software, text message care plans can either be allocated a default day of delivery (e.g. Mondays) or a frequency schedule starting a specified number of days after a text message protocol is added to a patient's profile (e.g. start text message protocol 3 days after protocol allocation). Feedback from the focus groups in the co-design of intervention concept study highlighted the importance of avoiding text message content delivery which could result in patients seeking further information when their usual healthcare providers would be closed, so not over the weekend or on a Friday (see Section 6.1.6).

To avoid the messages being sent on Fridays, Saturdays or Sundays this required the use of an allocated weekday for each of the text messaging protocols with long-term condition specific content. Although these days can be changed for individual patients, to limit the requirement for this level of personalisation by pharmacists, I decided to create a fortnightly schedule with each long-term condition allocated a specific day of the week for text messages to be delivered. The two-week cycle of long-term conditions and their allocated schedule can be found in Table 18.

The relative position of the days was distributed to avoid clusters of days where long-term conditions were commonly co-morbid. For example, text messages relating to diabetes were delivered in Week 1 of the cycle, and hypertension in Week 2 so that someone with both these conditions would be contacted weekly, rather than on two days in the same week and then have no contact in the second week cycle. The exception to this was weight monitoring for heart failure (see Section 7.1.5.6) which was identified as requiring weekly monitoring

and therefore a Friday was used to prevent clashes with the delivery of other content, this is explained further in the heart failure section. Messages which were not specific to long-term conditions would be delivered in addition to this schedule.

Table 18 Two-week cycle for long term condition text message content delivery

Week 1		Week 2	
Monday	Asthma	Monday	Chronic Obstructive Pulmonary Disease
Tuesday	Chronic Heart Failure	Tuesday	Ischaemic heart disease
Wednesday	Depression	Wednesday	Chronic pain
Thursday	Hypertension	Thursday	Type 2 Diabetes
Friday	Heart failure monitoring only	Friday	Heart failure monitoring only

Text message content for each long-term condition would serve one of three functions to increase reflective motivation to take medicines based on the narrative synthesis systematic review and use of the Behaviour Change Wheel (BCW) described to create the 'personalisation questionnaire to intervention components' prototype described in Chapter 6 (see Section 6.1.5). These functions were:

- Reducing concerns associated with medication-taking
- Increasing perceived necessity for medication-taking
- Providing feedback on the effectiveness of medicines, by supporting the patient with health monitoring associated with their long-term condition(s)

There were two additional functions of text messages which were not long-term condition specific. These would promote habit formation as part of the automatic motivation pathway in the BCW:

- Monitoring patients' performance of the taking medication behaviour
- Delivering 'Prompts/cues' for taking medication

Text message functions were then blended in text message protocols to be selected based on patient responses in the personalisation questionnaire. This blend of text message protocols is shown in Figure 14. The detail of how the text message library was created to deliver these functions within these text messaging protocols is described in the following sections. Some amendments to the selection process were also made between the co-design of intervention concept study and the present study based on literature searching during the analysis of that study (see Section 6.4.2) and these changes are reflected in the live simulation study described in this chapter. The names of the text message protocols were also amended based on feedback from the pharmacy delivery co-design study (discussed in Section 8.5.3) which took place after the present study chronologically, but the original protocol names have also been included for cross-referencing purposes.

7.1.2 Selection of BCTs for inclusion

The selection of BCTs to be delivered using text messages was informed by the narrative synthesis systematic review, feedback from the co-design of intervention concept study and guidance from the BCW[295]. The identification of content for including in text messages was also supplemented based on analysis of Patient Information Leaflets (PILs) published by UK charities for each of the long-term conditions included within the scope of the TIMELY intervention. The PILs used for each of the long-term conditions can be found in Table 19. Each PIL was coded for BCTs included within the content which targeted behaviours related to medication-taking.

Using these PILs was a substitute for bespoke co-design approach where messages would be co-developed with patients and healthcare professionals for each of the long-term conditions specifically for this intervention. However, as there was high-quality patient information available for each long-term condition, already co-designed with patients and healthcare professionals, this offered some efficiencies as part of the design process. This

would have been especially challenging given the number and breadth of long-term conditions which we aimed to include in the intervention.

A disadvantage of this approach was that this information was not designed for delivery using text messages and often did not specifically focus on medication. Information was also not always targeted towards any behavioural change by the target audience. However, analysis of the leaflets allowed for some of this to be identified and therefore translated into the new delivery format of text messaging. And as these messages would still be tested with patients, using the PILs offered a good starting point for design which could be re-iterated using feedback as part of the ongoing co-design process.

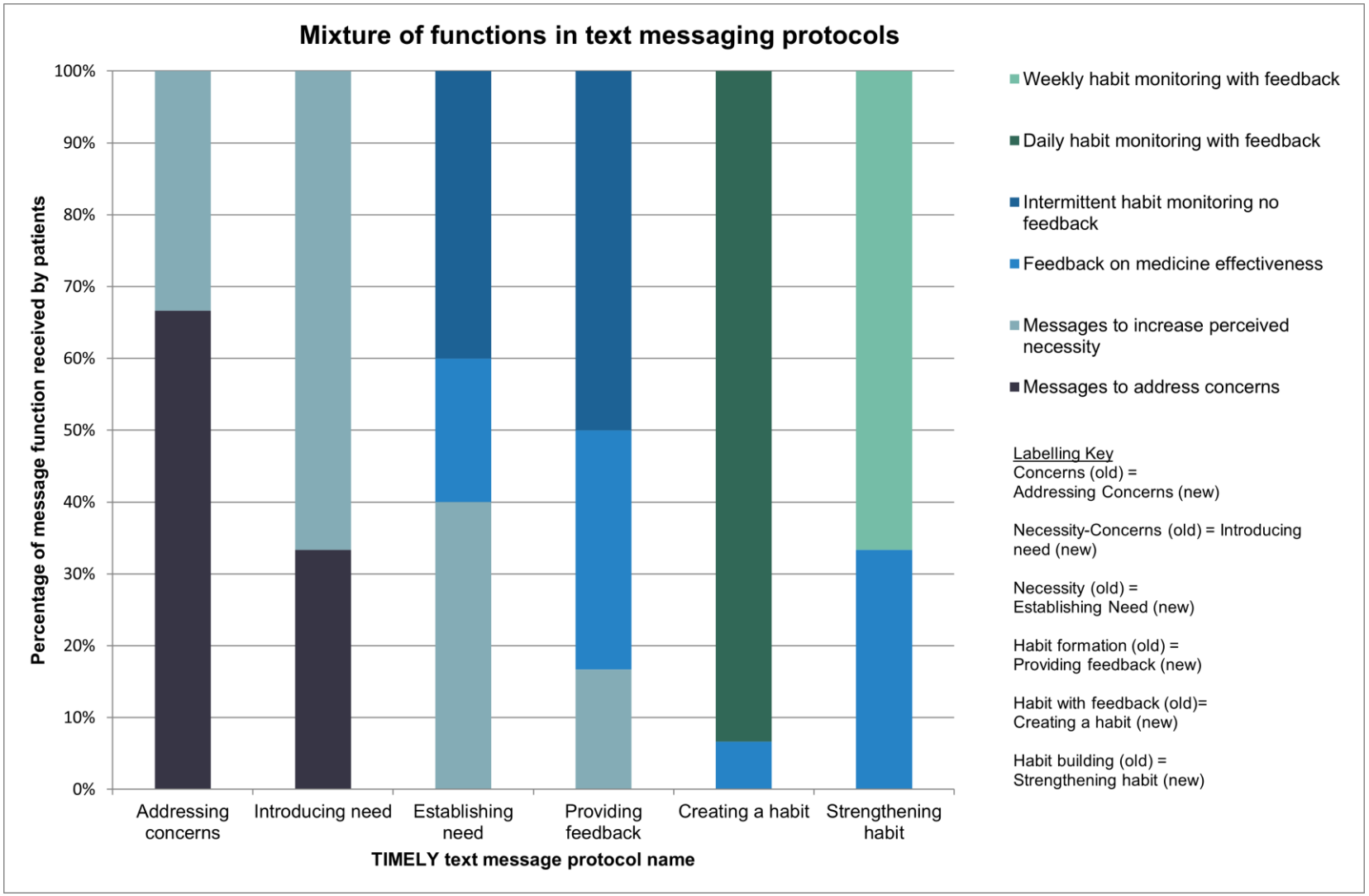


Figure 14 Mixture of text message function as percentage of text messages included in each TIMELY protocol

Table 19 Patient information leaflet sources used in development of TIMELY text message library

Long-term condition	Patient Information Leaflet	Publishing Charity
Asthma	Living well with asthma[296]	Asthma UK
Ischaemic heart disease	Angina and living life to the full[297] Medicines for my heart[298]	British Heart Foundation
Heart failure	Living with heart failure[299]	British Heart Foundation
Hypertension	I've got my blood pressure under control[300]	British Heart Foundation
COPD	Medications for COPD[301]	British Lung Foundation
Type 2 Diabetes	Everyday life with Type 2 Diabetes[302]	Diabetes UK
Depression	Making sense of antidepressants[303]	MIND
Chronic pain	Managing your medications[304]	Pain Concern

7.1.3 Reducing concerns associated with medication-taking

BCTs selected to reduce concerns associated with medication-taking were first suggested in the prototype 'Principles for intervention personalisation document' used in the co-design of intervention concept study. One suggested BCT was 'Commitment'. However, as this message was designed to be specific for a long-term condition, it could mean that a patient with four long term conditions, could receive four versions of a commitment text message. There was also the issue that, if used generically, for example, asking for a commitment for generic medication-taking, whether this BCT would continue to have the same impact. So, this BCT was not included in this live prototyping study. Another message not included in the library from the co-design of intervention concept study was that of Monitoring of emotional consequences as it made use of a rhetorical question.

To identify candidates for content relating to the remaining two BCTs, 'Reduce negative emotions' to reduce concerns around side effects, and 'Framing/ re-framing', examples were sought from the published PILs (see Table 19) and examples highlighted in the narrative synthesis systematic review. One example was found for the 'Framing/ reframing' BCT, in

the PIL from MIND highlighting depression as an illness, which should not have shame attached to its treatment. Other examples of the use of the 'Framing/reframing' BCT were examples using patient voice within the PILs. As the TIMELY intervention would use Alice's voice, these could not be translated into text message format, and therefore no messages using this BCT were also included for other long-term conditions.

The example for 'Reducing negative emotions' in the co-design of intervention concept study related to the taste of a dispersible tablet formulation. Within the narrative synthesis systematic review, side effects from medication were identified as a potential cause of anxiety for patients, and where interventions provided reassurance about side effects, this was coded to the 'Reduce negative emotions' BCT. Side effects are one of the most common concerns associated with medication-taking[34]. Providing appropriate advice about side effects for common medications used in each of the long-term conditions included in the TIMELY intervention was therefore a key objective for the 'reducing medication concerns' message function.

A common BCT included within the PILs was 'Information about health consequences', but where the consequences were relating to side effects, rather than the benefits of medication-taking. Therefore, to support the identification and discussion of side effects for medication, text messages were designed for each of the long-term conditions which would combine information about side effects and either provide reassurance to deliver the 'Reduce negative emotions' BCT or use the BCT 'Prompts/cues' targeted at the behaviour 'Asking for medication support'. This reflected the findings from the narrative synthesis systematic review (see Section 5.4.2.4). Where 'Prompts/cues' would be used, these messages direct patients to discuss concerns with the community pharmacist. This could then allow the pharmacist to deliver the BCT 'Social support (unspecified)' for the behaviour taking medication and allow the assessment of any side effects.

However, as the TIMELY intervention would be long-term condition specific rather than medication specific, care needed to be taken when writing messages about side effects. Information about side effects was restricted to the medicines which are most used in the long-term conditions covered and were written to use more generic language such as "medicines for your blood pressure". Where a class of medicines was used almost universally for a long-term condition a group or specific drug, such as 'statins' for use in patients with ischaemic heart disease for example, these names were used. Where no content examples existed from the narrative synthesis studies or in PILs, the NHS.uk website was used or information from pharmaceutical manufacturer PILs.

An additional BCT which was included for the 'reducing medication concerns' function was that of Identification of self as role model. This had been used in a study from the narrative synthesis examining an intervention for use in Type 2 Diabetes[276]. This was included in the 'reduce medication concerns' function as it acknowledged a concern of uneasiness about taking medicines and attempted to compensate this by encouraging the patient to be an example to others.

"If you are uneasy with taking diabetes medications in front of others, do it anyway and set an example of how important it is to take care of yourself. Alice"

7.1.4 Increase perceived necessity for medication-taking

The 'Principles for intervention personalisation document' prototype used in the co-design of intervention concept study (see Table 10) suggested four potential BCTs which could be used in text messages where patients had a low score for perceived necessity for medication. These included 'Information about health consequences', 'Salience of consequences', 'Information about social and environmental consequences' and 'Credible source'.

There were many examples amongst the PILs to provide content relating to information about health consequences. However, examples of studies or PILs using the BCT 'Salience of consequences' could not be found. One example had been created for the co-design of intervention concept study prototype: "Uncontrolled diabetes can damage the blood supply to your feet. This can lead to amputation." However, it was an example of a BCT which healthcare professionals were less comfortable with (see Section 6.3.5). Other studies have also excluded this BCT from delivery in diabetes[276] although these study authors had linked this to the BCT 'Anticipated regret'. As both instances of feedback came from healthcare professionals rather than patients, this message remained in the BCT library for the co-design of intervention delivery with patients study although was not used in any other long-term condition.

'Information about the social and environmental consequences' was another BCT which healthcare professionals had mixed views about in the co-design of intervention concept study. However, when discussed at a steering committee, it was felt that delivery of this BCT remained of potential value and further consideration. Finding credible information to deliver this BCT was however difficult. The final database includes just two messages including this BCT, one for hypertension and another for Type 2 diabetes.

Use of the 'Credible Source' BCT was highlighted in the narrative synthesis for potential to deliver the Persuasion intervention function, but was little used amongst the studies included. To deliver this BCT within the TIMELY intervention, PILs from charities were used as a replacement for specifying a healthcare professional group as suggested in the original co-design of intervention concept study prototype. In one instance for the hypertension messages to increase perceived necessity, the NHS as a credible source using information provided by the NHS.uk website.

The BCT ‘Social support (unspecified)’ was also included to suggest that patients contact their pharmacist if they felt that their medicine was no longer needed. This was to acknowledge evidence that there may be medicines which are prescribed that are no longer needed and could be candidates for deprescribing[286].

7.1.5 Provide feedback on the outcomes of taking medication

The final function of text messages specific to long-term conditions was those to provide feedback on the outcomes of taking medication. In the narrative synthesis, providing feedback on the outcomes of behaviour as a BCT, in this case health improvements resulting from taking medication, seemed to be a way of increasing adherence to medicines. In most studies, this was combined with the use of the ‘Biofeedback’ BCT. However, in some long-term conditions this was not possible, and so other studies made use of questionnaire tools to assess clinical control as a way of monitoring health, such as the PHQ-9 for depression[256]. Symptom experience was also measured for asthma[229] and heart failure[244]. The eight long-term conditions included in the TIMELY study were therefore selected in part due to the potential of incorporating this BCT into the intervention.

If the outcome goals were to be standardised as part of providing feedback on outcomes from taking medication, it was important that the method used to assess these were based on valid measurements. To identify potential candidates for assessing health outcomes, several sources were used including: intervention descriptions from the narrative synthesis systematic review (including communication with study authors), existing text messaging protocols published by the Simple Telehealth community, and validated symptom questionnaires.

Each feedback algorithm is represented as a flow chart which shows the text messages, and how responses from patients feed into the feedback which is sent in the reply. The flow diagram starts in the top left-hand corner of the page. Messages with a dashed border are

conditional, usually only sent if the patient does not reply. Feedback messages are colour coded, with green border indicating positive health outcomes or improvements, red indicating poor health or a decline in outcomes, and orange indicating suboptimal outcomes. Arrows indicate the order in which messages are sent. A summary of the sources and decisions made about monitoring of outcomes for clinical condition control will now be described for each of the long-term conditions contained within the TIMELY intervention.

7.1.5.1 Asthma

Two studies from the narrative synthesis included text messages which provided feedback on the outcomes of behaviour for asthma. Bender et al.[229] and Cottrell et al.[270] used questions which assessed symptoms associated with asthma control, including: night-time waking, symptoms limiting activities, and use of reliever inhaler. The study by Cottrell et al.[270] evaluated the use of Flo and so was also found in the Simple Telehealth community. However, the questions used in both studies were not validated. The Asthma Control Test (ACT)[305] however, is a validated tool and incorporates the assessment of these symptoms. The validity of the tool also allows the responses to be linked to a standardised assessment of control which enables appropriate feedback to be delivered to the patient following the submission of answers. The ACT has not previously been used for Flo as the technology had not permitted this, but with Alice there was the option to incorporate the delivery of the ACT using the two-way automated system. However, the ACT assesses symptoms over the previous four weeks, and has qualitative responses which underpin a score. To capture these using text messages, these responses needed to be adapted to enable the algorithms within the Simple Telehealth system to collect the required information, and also keep within the 160-character limit of a text message. The final asthma algorithm can be found in Figure 15.

7.1.5.2 Chronic pain

The decision to include chronic pain as one of the long-term conditions in the TIMELY intervention was driven mainly by its high prevalence (see Section 2.2). Two studies from the narrative synthesis systematic review included patients receiving medication for chronic pain[266,270]. However, Auger et al.[266] limited their intervention to the detection of adverse events and Cottrell et al.[270] only incorporated reminders. This required a search for a method of assessing pain outcomes within the peer reviewed literature. A review of pain outcome scales was identified[306] as a starting point to identify potential options. The Brief Pain Inventory (BPI)[307], which included questions which assess the effectiveness of medication, has also been validated for use in primary care in patients with non-cancer pain[307] and was therefore selected as the instrument of use. However, the instrument in its original form is made up of 15 questions. To translate this into text message monitoring of outcomes, I chose two of these questions to use. One question to assess average pain symptoms, and one to assess the effectiveness of pain-relieving medication.

A change in pain score of 2 points for the BPi is considered to be clinically significant when used in research to evaluate treatments for pain[306] and so this was used as a cut-off point for the feedback on the overall assessment of pain within the algorithm. There was no standard for relief from pain, so I decided to have a cut-off point of 5. This assumed that if pain experience was halved by taking medication, that seemed subjectively to be a good performance, but less than this might require further investigation and assessment. The final algorithm for pain assessment can be found in Figure 16

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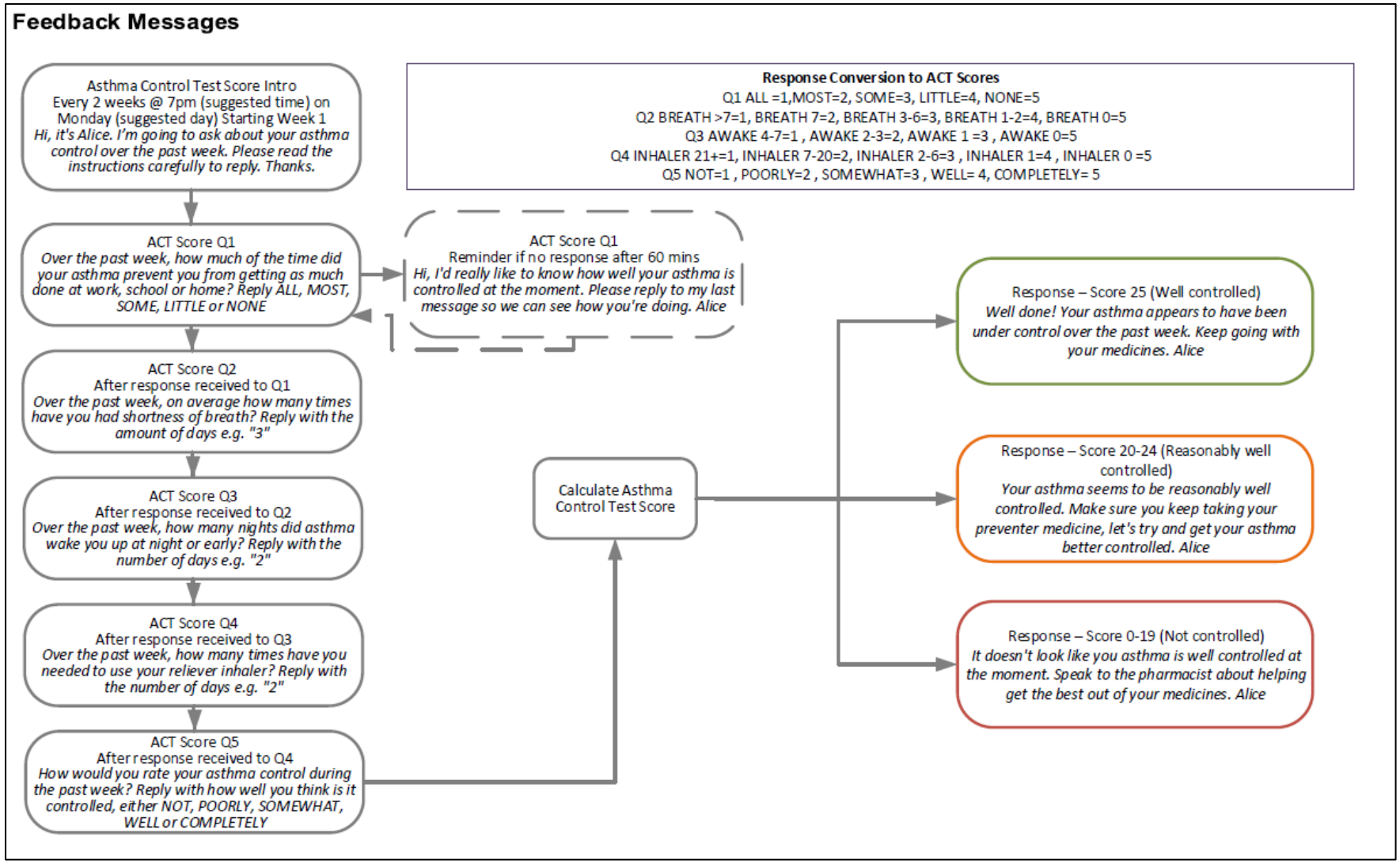

Figure 15 Text messages and algorithm to provide feedback on outcomes of taking medication for asthma in live prototype study

7.1.5.3 Chronic Obstructive Pulmonary Disease

Cottrell et al.[270] also included reminders for inhaler medication for Chronic Obstructive Pulmonary Disease (COPD) alongside their text message protocols for asthma. Vollmer et al.[230] also included COPD in their intervention, but this targeted the behaviour of obtaining medication rather than taking medication and did not include any monitoring of health related outcomes. Within the Simple Telehealth community, NHS Lanarkshire in Scotland had developed text messages for Flo which attempted to detect exacerbations of COPD by asking questions about sputum colour, breathlessness symptoms and oxygen saturation, with patients provided with a pulse oximeter to support engagement with the intervention. However, the plan for the TIMELY intervention was to use equipment which patients already have at home, rather than including provision of equipment such as a pulse oximeter to support engagement. It was unclear if the questions relating to sputum and breathlessness were validated. The aim to deliver the feedback on outcomes of behaviour was also to assess more general control of COPD symptoms, rather than detect exacerbations which would require further treatment using antibiotics and/or steroids, which seemed to be the aim of the NHS Lanarkshire protocol. The medications for COPD which the intervention would be targeting for TIMELY would be the regular administration of inhalers to support symptom control, therefore a question about breathlessness symptoms would seem to be the best fit to deliver the intended BCT. So, the breathlessness question from NHS Lanarkshire was adapted for the TIMELY intervention. The full algorithm can be found in Figure 17.

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7.1.5.4 Depression

Four studies included in the narrative synthesis systematic review had attempted to support adherence to medicines for depressive disorders. As with chronic pain however, Auger et al.[266] only aimed to monitor adverse events associated with taking medication.

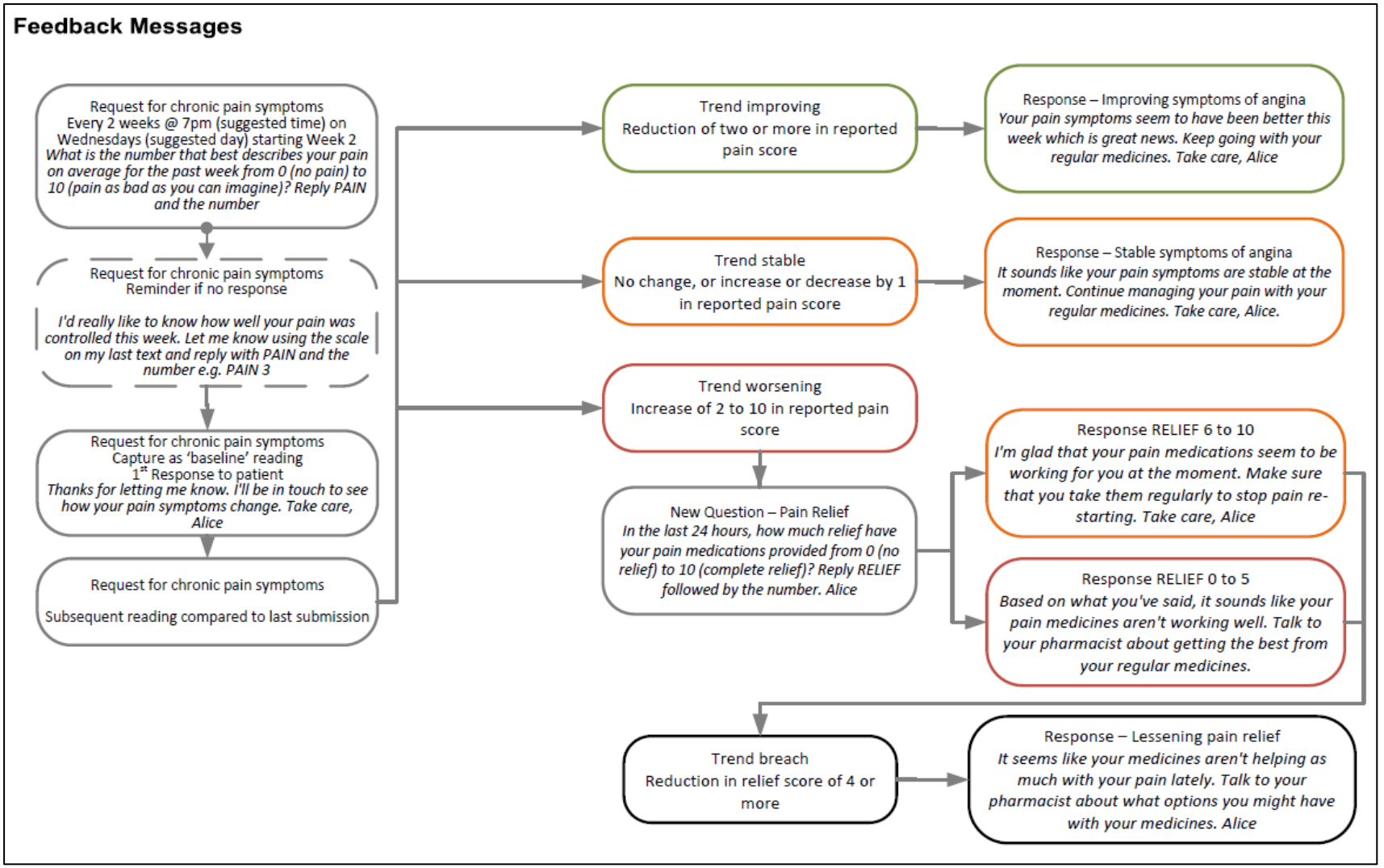


Figure 16 Text messages and algorithm to provide feedback on outcomes of taking medication for chronic pain in live prototype study

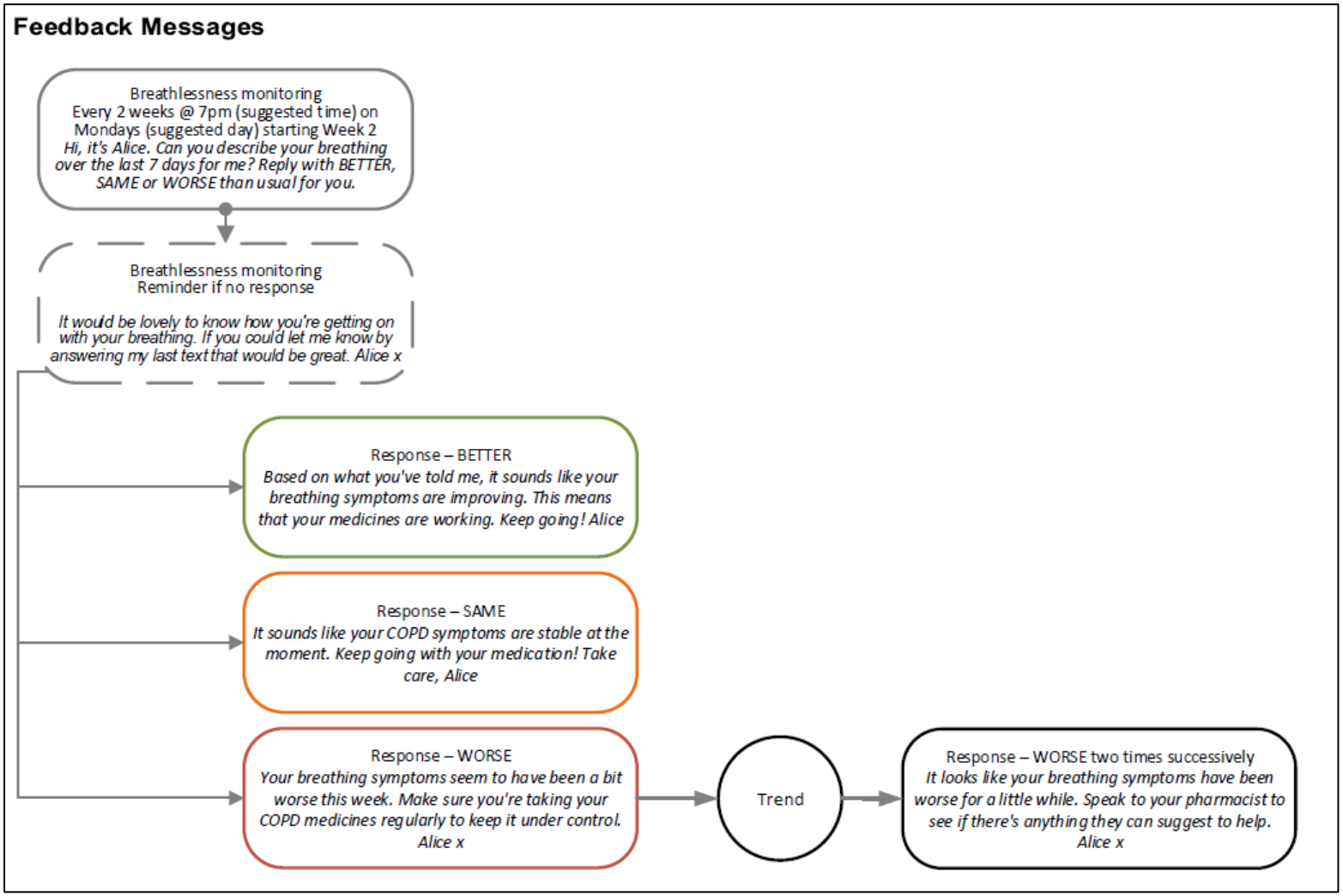


Figure 17 Text messages and algorithm to provide feedback on outcomes of taking medication for chronic obstructive pulmonary disease in live prototype study

Zabinski et al.[259] focussed on taking medication as a behaviour so did not include content relevant to the feedback on outcomes of behaviour BCT. Stuart et al.[238] studied taking medication specifically in patients with depression, but only delivered BCTs at taking medication and did not link this to any outcomes. Aikens et al.[256] however used IVR to ask questions aligned to the PHQ-9 instrument[308] to provide feedback on outcomes of behaviour. Whilst the study by Aikens et al.[256] did not seem to improve clinical outcomes or medication adherence, as low mood is an independent predictor of overall medication adherence, improvement in mood was always going to be difficult to achieve. From the TIMELY intervention perspective, the aim is not necessarily to improve medication adherence to antidepressants for patients only with depression, but to support patients who have depressive symptoms co-morbid with other long-term conditions. Therefore, including questions about mood to provide feedback to patients about the effectiveness of their antidepressants remained a potential mechanism worth exploring.

The script for the IVR intervention was provided by John Aikens following an email request. As the intervention was completed via IVR, the study authors were able to administer the full PHQ-9 instrument relatively easily. Advice from the STPSO was not to exceed five questions as part of the interaction with patients via text messaging, and therefore using the full PHQ-9 instrument was not viable. However, a search of the Simple Telehealth community revealed an example of using the PHQ-2[309] instrument in text message format. The PHQ-2 instrument has been found to be sensitive and specific at detecting patients with depressive symptoms. A version of the PHQ-2 had also been developed by the West Midlands Academic Health Sciences Network for a project using Flo. In this version, Florence requested a numerical value for the number of days over which patients had experienced depressive symptoms, rather than the qualitative responses in the original instrument, and these adaptions were kept for the TIMELY intervention.

However, the text message protocols developed by the Simple Telehealth community exist alongside support plans which are agreed in advance. As this would not be the case for the TIMELY intervention additional safety netting was included. In addition to the two PHQ-2 questions, questions about thoughts and plans for self-harm for those with higher PHQ-2 scores were added from the PHQ-9. Responses to these also included links to the Samaritans. This approach mirrored the intervention by Aikens et al.[256] which was also designed for remote administration with automated responses. The flow diagram which represents the algorithm of text messages to support feedback on taking medication for depression can be found in Figure 18 and Figure 19.

7.1.5.5 Type 2 Diabetes Mellitus (T2DM)

Interventions designed to support medication adherence in diabetes were common in the narrative synthesis, with eleven studies included in the review. Of these, five made use of the BCT 'Biofeedback'[239–241,257,258,263], two then used this to deliver the BCT 'Monitoring of outcomes of behaviour by others without feedback'[241,263] and Aikens et al.[257,258] used a combination of the BCTs 'Feedback on the outcomes of behaviour' and 'Monitoring of outcomes without feedback'. The intervention by Aikens et al.[257,258] however relied on patients self-monitoring and recording their blood glucose independently, as the IVR requested the number of instances in which blood glucose levels had reached a particular threshold. Feedback was then provided via follow up within the wider intervention. The intervention by Katalenich et al.[239] was more focussed on the behaviour of self-testing, than the value of the measurement itself.

Similar to Aikens et al.[257,258], information about blood glucose readings were sent to a nurse for review in the interventions by Piette et al.[241] and Shane-McWhorter et al.[263], but how nurses responded to blood glucose measurements was not described to evaluate the inclusion of any further BCTs.

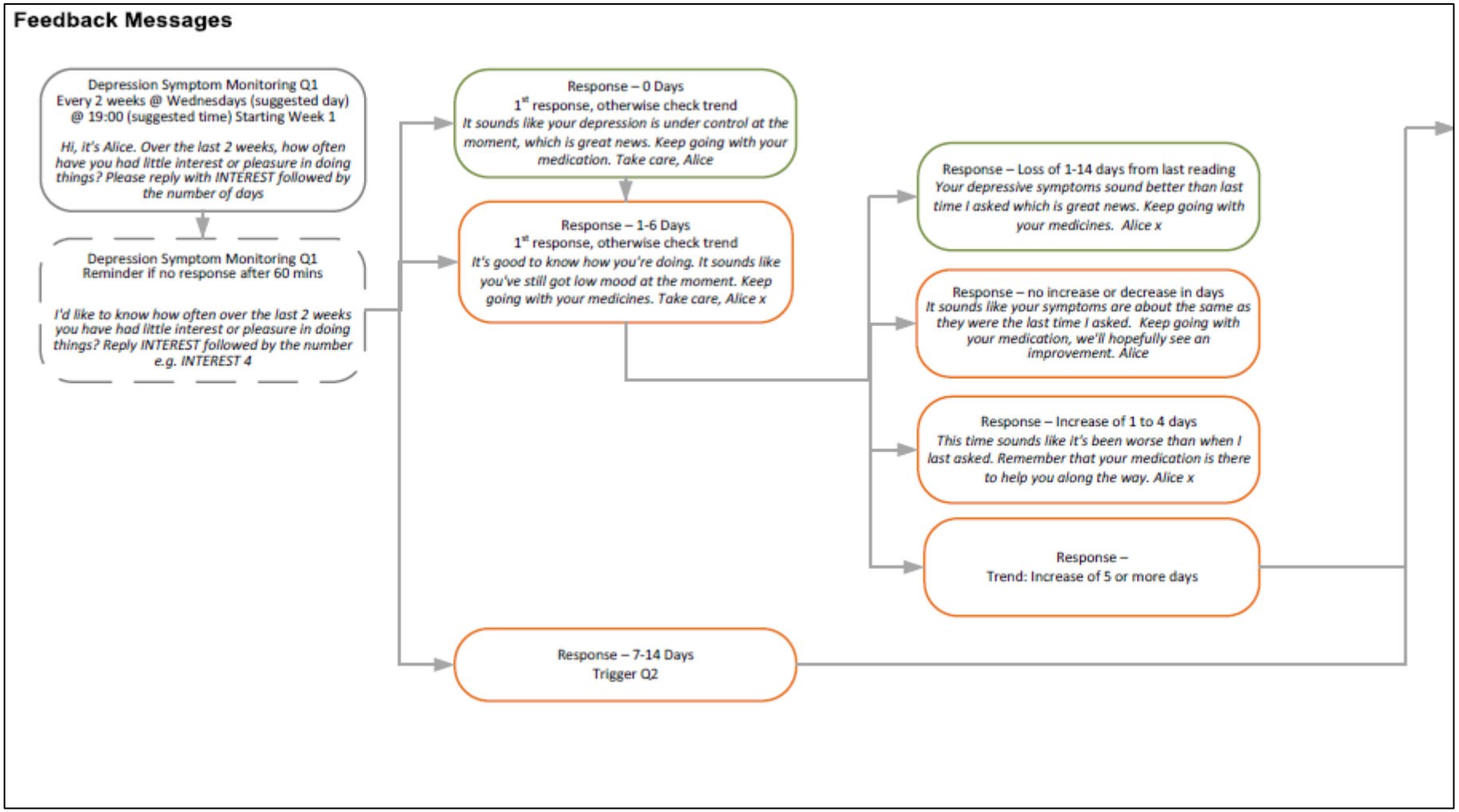


Figure 18 Text messages and algorithm to provide feedback on outcomes of taking medication for depression in the live prototype study (Part 1 of 2)

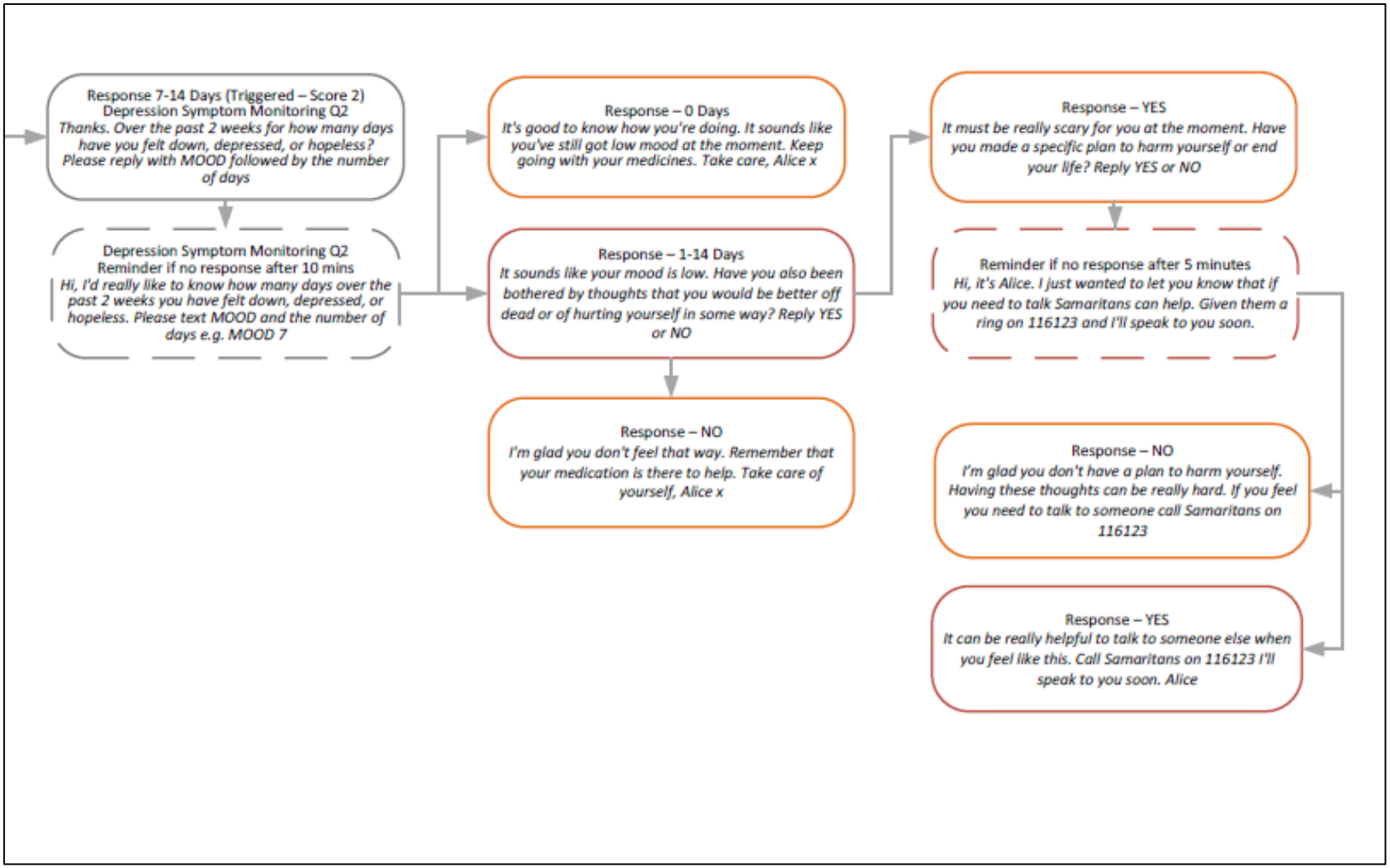


Figure 19 Text messages and algorithm to provide feedback on outcomes of taking medication for depression in the live prototype study (Part 2 of 2)

In guidance published by the National Institute for Health and Clinical Excellence (NICE) in 2015, Self-Monitoring of Blood Glucose (SMBG) was not recommended for routine use in adults with T2DM[310]. This is in contradiction with the theoretical model in use here, which suggests that feedback on the outcomes of behaviour can be a tool to increase reflective motivation associated with taking medication. Most of the included studies in the narrative synthesis also seemed to consider SMBG a key self-management behaviour for T2DM, but this was not necessarily framed in the context of medicines-taking. The position by NICE however, did make designing a feedback protocol for the TIMELY intervention more challenging. Amongst the Simple Telehealth community, a protocol had been designed by South Tyneside NHS Foundation trust which used the diagnostic range of 5-7mmol/L as the 'desirable' range for blood glucose readings, with advice for treating hypoglycaemia where the value submitted was below this and following dietary and exercise advice where readings submitted where higher. This was used as the basis for the text messaging protocol, with some trends added for readings which were consistently low, within range, or higher than this, aligned to the trends used in the IVR assessments by Aikens et al.[257,258]. The flow diagram which describes the text messaging protocol for T2DM for TIMELY can be found in Figure 20.

7.1.5.6 Heart Failure

Two studies from the narrative synthesis systematic review included patients with Heart Failure with reduced Ejection Fraction (hFrEF) as their participants[244,259]. Piette et al.[244] made use of the BCT 'Monitoring outcomes of behaviour by others without feedback', using a combination of heart failure symptoms and weight. However, rather than these inputs automatically generating feedback, reports were compiled and sent either to the patients' healthcare professional (in this study the control arm) or a designated care partner (the intervention arm). However, the study did specify threshold weights which classified a patient input as urgent due to a 'significant' weight increase. They classified a significant weight

increased as either: a 5lb increase over 1 or 2 weeks, a 7lb increase over 3 weeks or an average gain of 2lb per week over 3 weeks.

Within the Simple Telehealth community, NHS Scotland had produced a text messaging protocol for Flo which made use of daily weights to monitor patients with heart failure. These then referenced the 'Traffic Light' system which was developed by the Pumping Marvellous Foundation[310]. These resources support an additional symptom check following on from monitoring of weight. However, this additional assessment would be difficult to incorporate into the automated text messaging protocol for TIMELY. The zones also did not appear to be validated. The protocol was designed for daily weights, which was more intensive than the initial two weekly messages that were planned. As part of developing the protocol, I spoke to a heart failure specialist pharmacist who said that she advised that heart failure patients needed to monitor their weight at a minimum weekly. Therefore, I made the decision to incorporate weekly weight monitoring for heart failure patients, with thresholds for referral for patients to speak to the pharmacist and potential assessment of symptoms at the thresholds used by Piette et al.[244]. The version of the text messaging protocol developed for the co-design of intervention delivery study for heart failure patients can be found in Figure 21.

7.1.5.7 Hypertension

Many of the studies included interventions targeting cardiovascular disease, with nine of these specifically targeting hypertension[237,250–252,254,259,263,266,270]. Of these, six used Blood Pressure (BP) monitoring to deliver the BCT 'Biofeedback'[237,250–252,263,270]. One study monitored blood pressure as an outcome of behaviour without feedback [251] and four provided 'Feedback on the outcomes of behaviour'[237,250,252,270]. The study by Cottrell et al.[270] was also from the Simple Telehealth community.

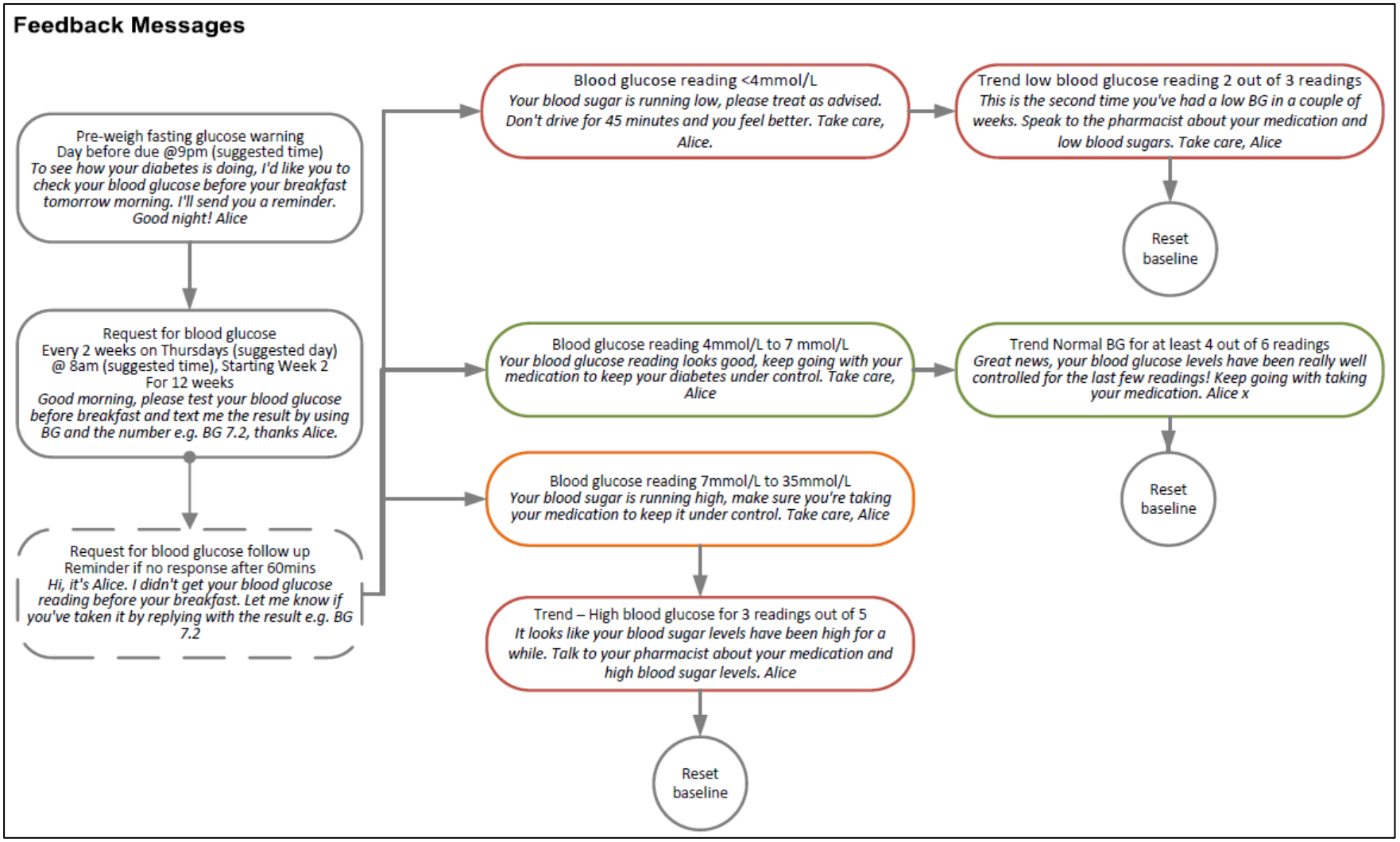


Figure 20 Text messages and algorithm to provide feedback on outcomes of taking medication for type 2 diabetes in live prototype study

The standard against which BP measurements were compared across the studies was standardised and aligned to the recommendations by NICE for home blood pressure monitoring which are 5mmHg lower than those for in-clinic thresholds[311]. This allowed some of the studies to automate the feedback back to patients[250,252,270]. However, Bove et al.[250] only sent feedback automatically to the patient if the value was within the desirable range, if the value was outside of this, it was forwarded to a nurse to follow up the patient. Feedback was also only delivered via nurse follow-up for blood pressure readings submitted via the digital communication intervention for the studies conducted by Shane-McWhorter et al.[263] and Friedman et al.[251]. Vollmer et al.[237] provided these BCTs using measurements taken in clinic and sent to the patient in a report via the wider intervention.

The TIMELY intervention replicated the approaches described by studies in the peer reviewed literature and using guidance for home BP monitoring published by NICE. This included the use of standardised cut-off points for submitted readings, but with two levels of out-of-range thresholds used in the version produced by Cottrell et al.[270] for the Simple Telehealth community. The flow diagram which shows the text messages and the responses to patients can be found in Figure 22.

7.1.5.8 Ischaemic Heart Disease

Eight studies included in the narrative synthesis systematic review targeted patients with Ischaemic Heart Disease (IHD)[232,233,235–237,254,255,259,266]. Of these only one used the BCT 'Biofeedback'[237] which was delivered by providing patients with a report of results from a clinic visit as part of the wider intervention. This meant that the study also delivered the 'Feedback on outcomes of behaviour' BCT. However, as community pharmacies in the TIMELY intervention would not have access to this information, this would not be a feasible way to deliver this feedback. Providing clinical information such as cholesterol levels with the frequency required to provide feedback to patients about taking medication on their health

would also likely be difficult. The Simple Telehealth community also had no examples of self-monitoring ischaemic heart disease using Flo.

A search of the peer-reviewed literature for validated tools which could assess the symptoms associated with ischaemic heart disease found a review of health-related patient reported outcome measures in cardiovascular disease[312]. From this review, the Seattle Angina Questionnaire (SAQ) [313] was identified which contains 11 questions about functional status associated with IHD. Response options were however qualitative and similar to the text message protocol for depression. An automated algorithm with quantitative response options was needed. Another tool identified from the review was the Cardiac Symptoms Survey (CSS)[314] which used a rating scale similar to that used in pain. This was therefore used as the basis of the text messaging protocol for the TIMELY intervention. However, determining score thresholds for IHD was difficult. Whilst the aim of treatment for IHD is for patients to be symptom free, both the SAQ and CSS work on a model of change rather than definitive values. Therefore, the text messaging protocol for TIMELY used trends to track changes in patients' responses rather than absolute values. As a safety net, what is called a trend 'breach' was also included whereby patients reporting an increase in 10 or more instances of chest pain over the past 7 days were directed to speak to the pharmacist or NHS 111. However, this number is just from my (and my supervisors') judgement, as there was no standard available to support any other threshold. The full flow diagram for the TIMELY intervention can be found in Figure 23.

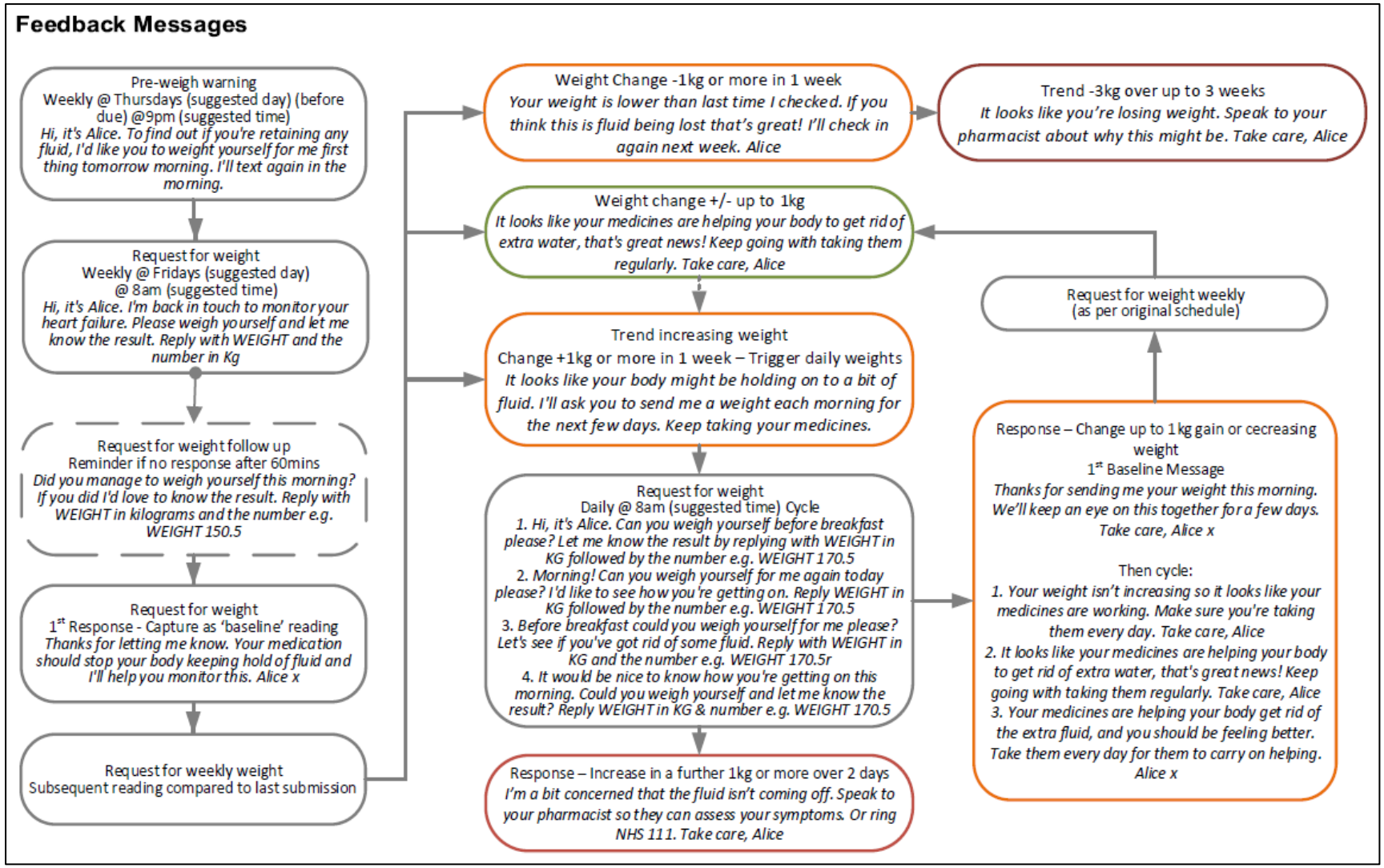


Figure 21 Text messages and algorithm to provide feedback on outcomes of taking medication for heart failure in live prototype study

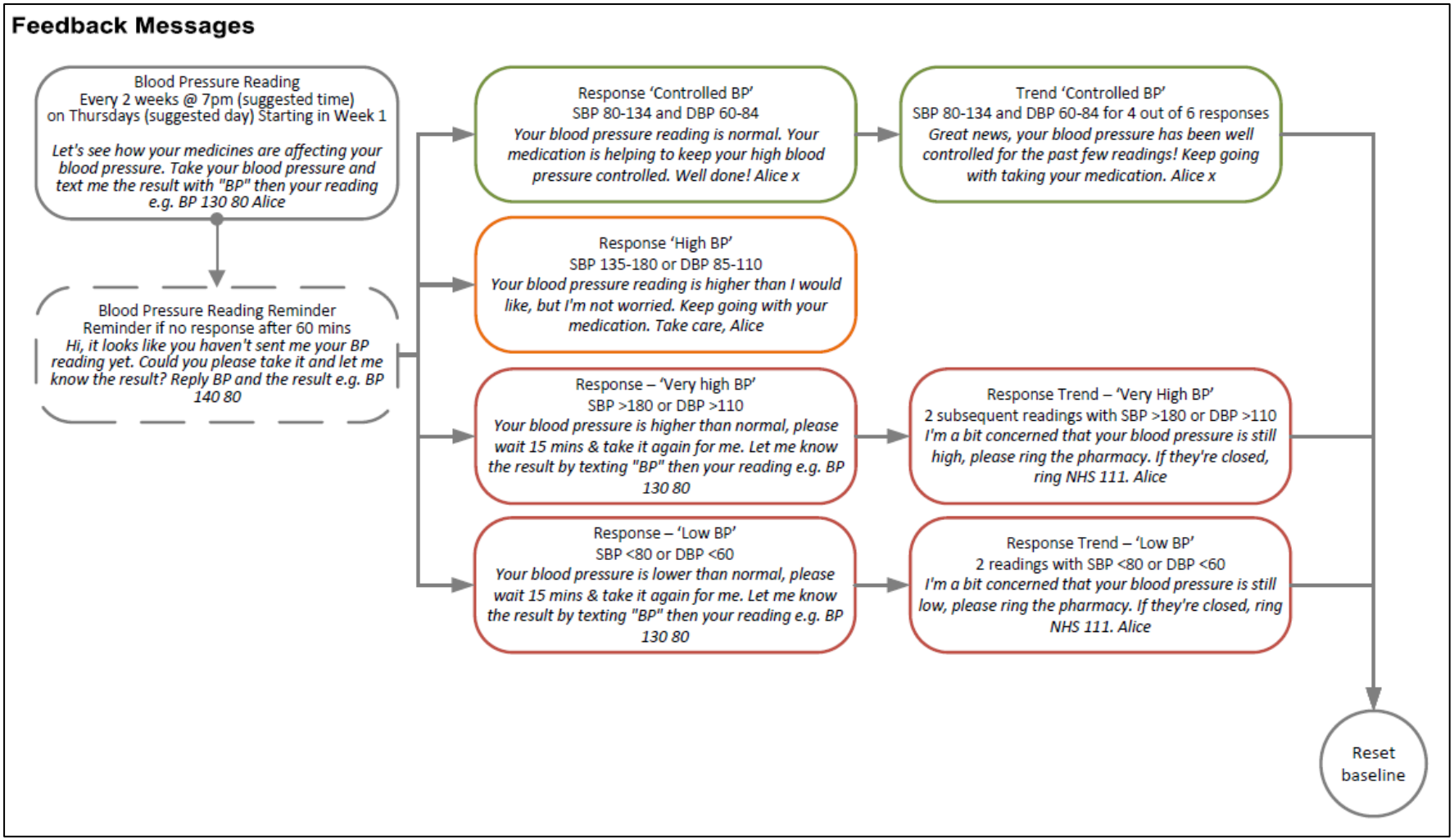


Figure 22 Text messages and algorithm to provide feedback on outcomes of taking medication for hypertension in live prototype study

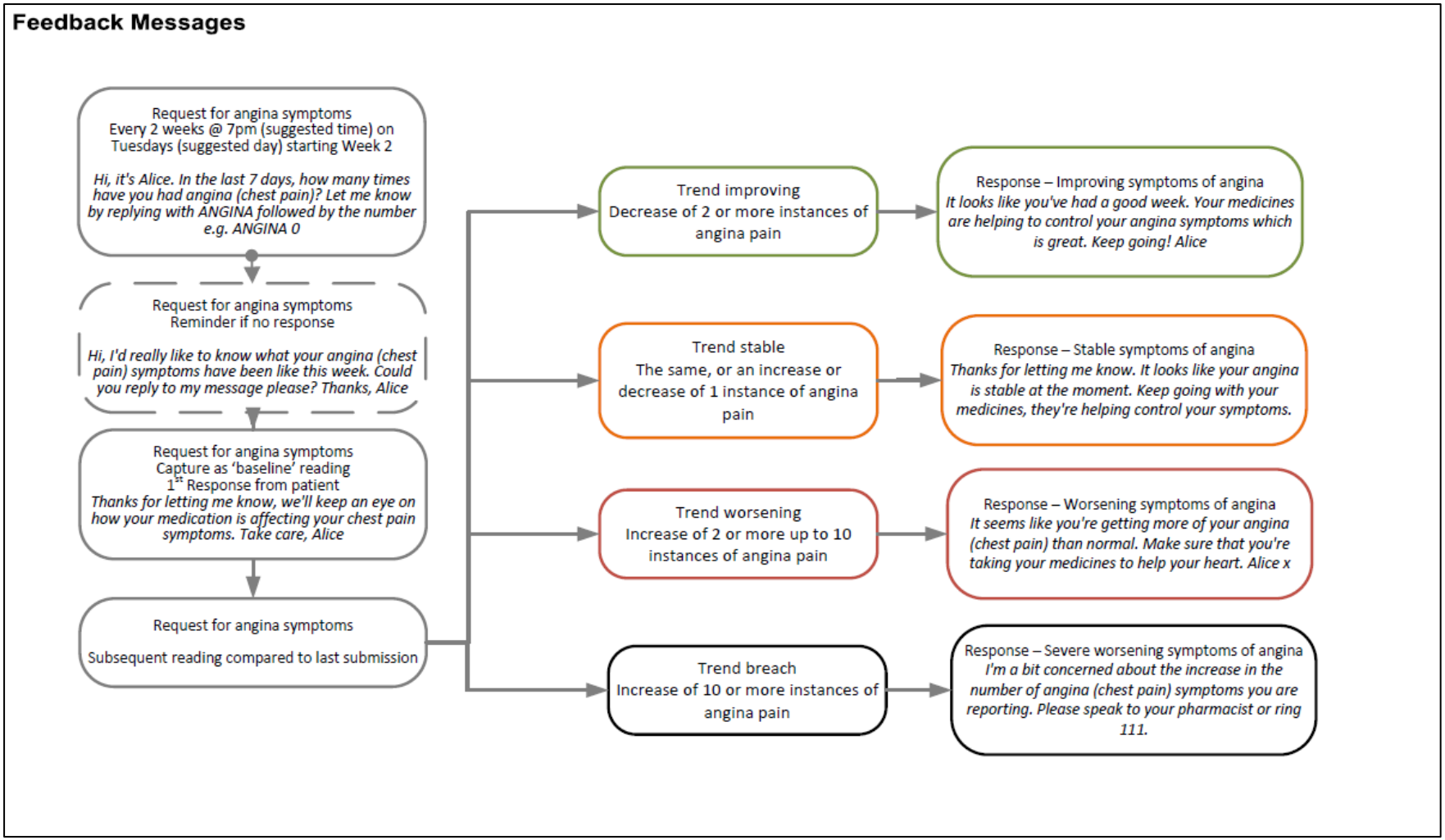


Figure 23 Text messages and algorithm to provide feedback on outcomes of taking medication for ischaemic heart disease in live prototype study

7.1.6 Monitoring patients' performance of the taking medication behaviour

In the narrative synthesis systematic review, many studies included mechanisms to monitor singular medication-taking (see Section 5.4.2.2). Those that included feedback for multiple medicines monitored obtaining medication rather than taking medication. A self-report was the most common method of monitoring taking medication and automating feedback. However, for the TIMELY intervention, a way of monitoring taking medication for multiple medicines using a self-report for automated responses was required. To do this, a new system for medication monitoring was created called 'Medication Times'.

A Medication Time (MT) is an instance where a patient self-administers a dose of one medication. It does not take into account the number of tablets or route of administration, only that a medication is taken at a particular time. To answer the question, how many MTs a person has, the number of medicines and the number of times they administer that medicine are combined.

The number of MTs needs to be calculated for each patient individually. The calculation starts by calculating patients' 'medication times' per day. All medicines the patient takes are included in the calculation, regardless of whether the long-term conditions they are being used to treat are included in the TIMELY intervention. Medication times apply to all dosage forms of medicines, including: tablets, inhalers, liquid medicines. When required medicines are not included in the medication times calculation. However, where a patient takes a regular medicine for which they adjust the dose according to their needs (e.g. for pain) the number of MTs which are normal for the patient should be included in the overall calculation.

Example of a MTs calculation:

Metformin 500mg tablets,	Take TWO tablets twice daily	Medicine 1, twice
Ramipril 10mg capsules,	Take ONE daily	Medicine 2, once
Atorvastatin 10mg tablets	Take ONE at night	Medicine 3, once

Gliclazide 80mg tablets	Take ONE tablet twice daily	Medicine 4, twice
Amlodipine 10mg tablets	Take ONE tablet in the morning	Medicine 5, once
Aspirin 75mg tablet	Take ONE tablet in the morning	Medicine 6, once

Therefore, this patient has 8 ‘medication times’ across the six medicines.

Three different levels of medication monitoring using MTs were created as follows:

- Intermittent medication monitoring without feedback
- Daily medication monitoring with feedback
- Weekly medication monitoring with feedback

The rationale for having these three levels of monitoring was those patients with lower medication adherence, likely to be those with the highest concerns and lowest perceived need for medication may respond negatively to medication monitoring. Where there is a desire to adhere to medicines but there is a lack of routine or maybe some doubts about medication effectiveness may benefit from lighter touch monitoring. Those with a good habit, would equally not benefit from intense medication monitoring and a weekly monitoring schedule was created. The most intense monitoring, daily monitoring with feedback, was designed to be used alongside the long-term condition protocols which aimed to demonstrate the effectiveness of medication on clinical outcomes delivering the ‘Feedback on the outcomes of behaviour’ BCT. This was to try and address the tension that changes in outcomes are unlikely to be achieved if patients are not taking a high proportion of their medication, and so this combination is designed to be relatively intensive to achieve an increase in medication-taking behaviour.

To deliver the BCT ‘Feedback on Behaviour’, the text messages would also need to have thresholds to analyse the number of MTs adhered to by the patient and provide an automated appropriate response. There are no consistent standards for thresholds at which medication adherence assessment tools consider a patient to be ‘adherent’[24,315], especially

where multiple medicines are taken. However, most agree that 100% of medicines taken is the most desirable level and 7 day self-report without missing a medication was used in evaluations of NMS for example[78,82]. A threshold of 80% is commonly used for 'good', and less than 50% is generally considered 'poor' adherence[24]. Therefore, the following four categories were devised for this feedback:

- 100% adherence is considered 'Perfect'
- 80% adherence is considered 'Good'
- 50-79% adherence is considered 'Normal'
- Less than 50% adherence is considered 'Suboptimal'

All medication monitoring messages were intended to be sent to capture taking medication throughout an entire day, or week up until the end of that day. For the text messaging protocols which included feedback on taking medication, the 'Social Reward' BCT was also included where medication adherence was reported as good, or signposting to the pharmacist where adherence was suboptimal. This was so that the pharmacist could deliver BCTs such as 'Problem solving' which could be more specifically tailored to the patient and the difficulties they were having based on the findings from the narrative synthesis systematic review (see pp. 148). The flow diagrams for each medication monitoring protocol can be found in Figure 24, Figure 25 and Figure 26.

A selection of 'top tips' messages were also designed to further promote formation of a medication-taking habit. These included examples from studies from the narrative synthesis systematic review and applying examples from the BCW, including the delivery of the BCTs 'Instruction how to perform the behaviour', 'Habit formation', 'Adding objects to the environment' and 'Prompts/cues'. These messages are shown in the daily medication monitoring flow diagram (see Figure 25).

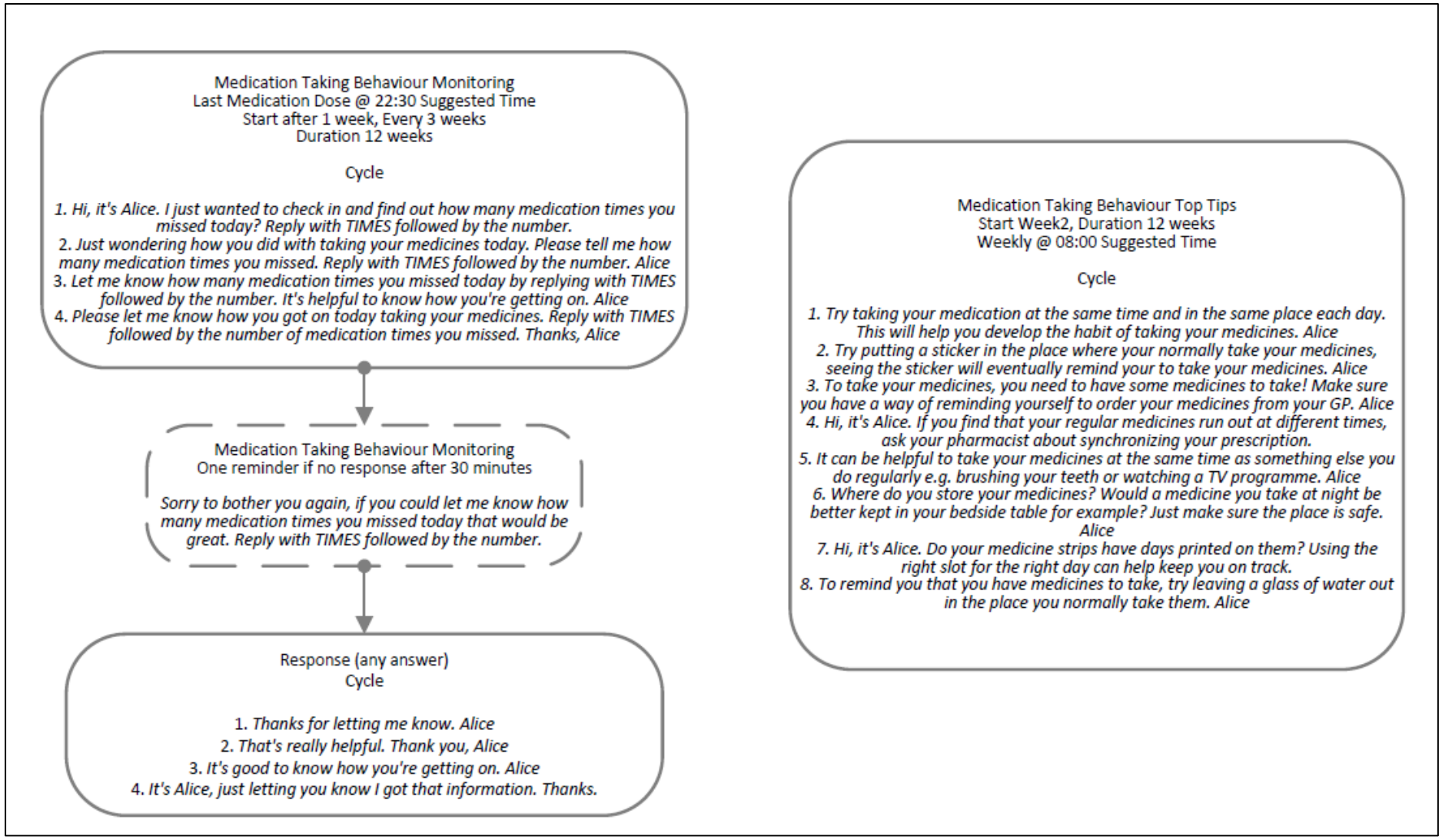


Figure 24 Text messages for intermittent medication monitoring without feedback and medication 'top tips' for taking medication in live prototype study

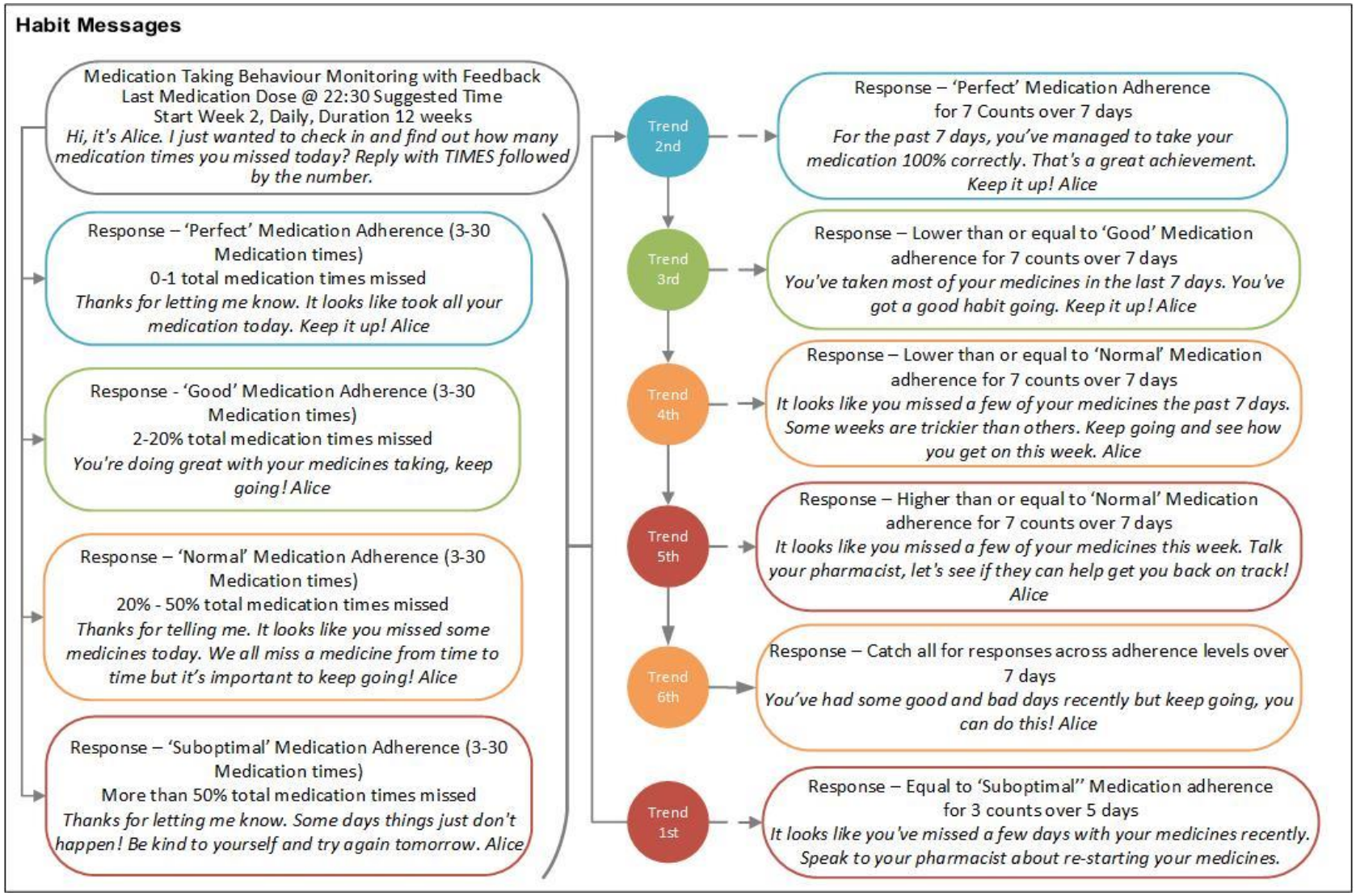


Figure 25 Text messages and algorithm for daily medication monitoring with feedback for use in live prototype study

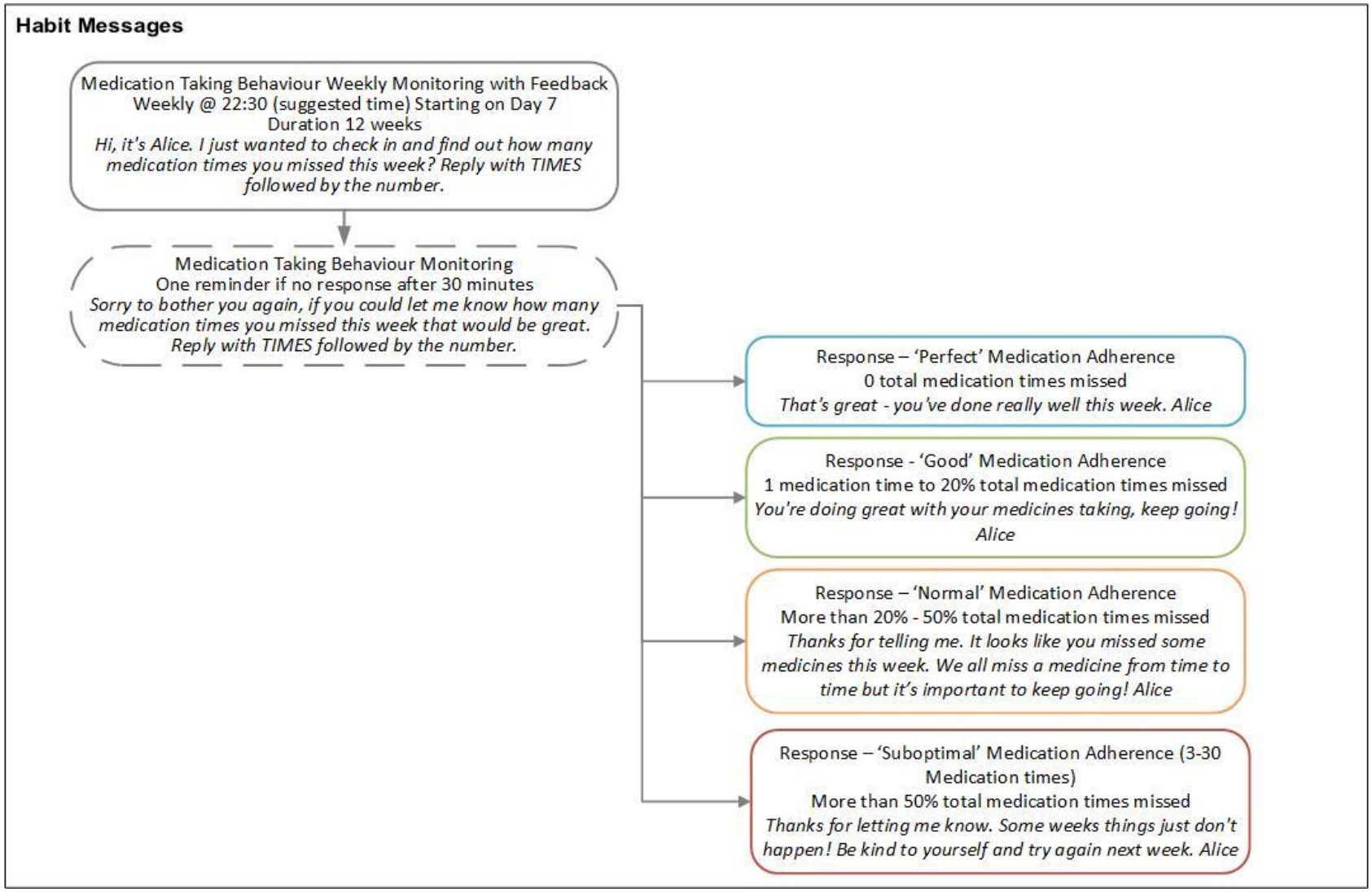


Figure 26 Text messages and algorithm for weekly medication monitoring with feedback for use in live prototype study

7.1.7 Delivering Prompts/cues for taking medication

As a result of feedback from the co-design of intervention concept study, the reminders in the live prototyping delivery were optional depending on patient preference. A series of reminders delivering the 'Prompts/cues' BCT for the behaviour of taking medicines were designed. Initially four collections of reminder types were designed for different times of day including: morning/ breakfast, lunchtime, evening/dinner time and night/ bedtime. Eight messages were written for each collection for variety as suggested in the Simple Telehealth guidance on writing messages.

7.1.8 Technical testing

Following creation of the text message library, technical testing of the protocols was performed. This involved creating the text-messaging care plans, adding them to a profile and interacting with Alice to check that the appropriate responses were received for the different pathways within the flow diagrams. Where a flow diagram included the detection of trends over time, an 'accelerated' version of the care plan was created to facilitate testing over the course of a day and allow testing in a shorter period. Where issues were detected, or care plans did not function as intended these were discussed with the STPSO. This enabled any technical issues to be resolved or make changes to the care plans.

7.1.9 The final text message library

The text message library consisted of 285 text messages. All messages contained at least one BCT with a further 92 having a second BCT resulting in the delivery of 377 BCTs. A summary of the target behaviour and the COM-B component which the BCT aimed to address can be found in Table 20. The most targeted behaviour by text messages was taking medication (89% of BCT delivery) followed by asking for medication related support (8%). A small number of messages (n=11) targeted the behaviour self-testing to support delivery of the feedback on medicine effectiveness BCTs. Just one message was targeted at obtaining medication, and this was from the 'top tips' messages (see Section 7.1.7). Of the

285 text messages, 170 (60%) were long-term condition specific. A summary of the number of messages written for each long-term condition and the function of each message can be found in Table 21.

Table 20 A summary of BCT delivery by target behaviour and COM-B component for the live prototyping text message library

Behaviour	Reflective motivation	Automatic motivation	Psychological capability	Social opportunity	Total
Taking medication	263	48	23	1	335
Asking for medication related support	2	0	1	27	30
Obtaining medication	0	0	1	0	1
Self-testing	4	7	0	0	11
Total	269	55	25	28	377

Table 21 Number of long-term condition specific text messages and their function in the TIMELY library

Long Term Condition	Feedback on medicine effectiveness	Reduce medication concerns	Increase perceived necessity	Total
Type 2 diabetes	10	5	7	22
Ischaemic heart disease	8	5	4	17
Hypertension	12	4	6	22
Heart failure	19	4	5	22
Depression	22	4	6	32
COPD	7	4	4	15
Chronic pain	10	4	4	18
Asthma	10	3	9	22
Total	93	33	45	176

Table 22 Number of instances of BCT delivery to support development of a medication-taking habit by text messages to support taking medication in the TIMELY library

Behaviour Change Technique (BCT)	Number of instances of BCT delivery
Prompts/cues	36
Monitoring of behaviour by others without feedback	14
Feedback on behaviour	58
Social reward	15
Habit formation	2
Adding objects to the environment	2
Instruction how to perform a behaviour	1
Verbal persuasion about capability	4
Total	131

In addition, there were 109 messages delivering BCTs to support habit formation for taking medication. The number of times that BCTs were delivered to support habit formation can be found in Table 22.

7.2 Prototype development for 'live' delivery with patients

A simulated version of the intervention using 'live prototyping' from the Human Centred Design (HCD) framework facilitated assessment of the TIMELY intervention incorporating a face-to-face consultation and a short period of receiving text messages from Alice. The duration of two weeks of text messages was suggested by the TIMELY steering committee. The aim was to assess acceptability of the TIMELY intervention when delivered 'live' and explore the potential mechanisms for the intervention, alongside possible context mediators for future outcome assessment.

As part of the live simulation process, the following prototypes were used in addition to the text message library.

- Patient information leaflet to advertise TIMELY intervention
- Patient information leaflet to support patients to interact with Alice
- Personalisation questionnaire
- Process selecting text message protocols based on the personalisation questionnaire
- The pharmacist 'enablement' consultation

Descriptions of how these prototypes were updated from the concept co-design study are provided in the following section and are available in Table 23

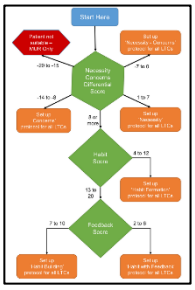
The live delivery included the following activities:

- Completing the personalisation questionnaire
- Having an 'enablement' consultation with me as a pharmacist
- Engaging in two-way text messaging with Alice for two weeks
- Where relevant, self-monitoring their health (e.g., blood pressure, blood glucose)

7.2.1 TIMELY Personalisation Questionnaire (Updated)

The TIMELY personalisation questionnaire prototype was largely found to be acceptable in the co-design of intervention concept study. Changes made for this study are discussed in Section 6.3 and an updated version of the questionnaire can be found in Table 23. Table 23 also includes an updated flow diagram for the selection of text message protocols based on the outputs from the personalisation questionnaire.

Table 23 Patient live prototype components and experience map questions

Design question from experience map	Prototype to be used	Click to view prototype	Scan to view prototype
Does the personalisation questionnaire successfully make the text message content feel tailored ?	TIMELY Personalisation Questionnaire (updated from the co-design of intervention concept study)		
	TIMELY Personalisation Questionnaire to Components Flow Diagram (updated from the co-design of intervention concept study)		
What would encourage patients to find out more about the TIMELY intervention?	Patient information leaflet for the intervention (invitation) (updated from the co-design of intervention concept study)		
What information will patient need before setting up the TIMELY intervention?	Patient information leaflet for the intervention (Alice users) (updated from the co-design of intervention concept study)		
How would barriers to medication adherence be assessed?	Delivery of the TIMELY enablement consultation (updated from the co-design of intervention concept study)	N/A	N/A

7.2.2 Enablement consultation with a pharmacist

The decommissioning of MURs[65] meant there was no longer a commissioned medication review service delivered by community pharmacies to act as a basis for the TIMELY intervention as suggested in the co-design of intervention concept study (see Section 6.1.4). Therefore, a replacement was designed called the 'Enablement consultation' to reflect the delivery of the 'Enablement' intervention function from the BCW. This consultation with the pharmacist includes the removal of Psychological Capability, Physical Capability and Physical Opportunity barriers to taking medication, the same as delivered in the MUR framework (and described in Section 6.1.4) and reflected in the TIMELY intervention programme theory. The components of the consultation identified in the co-design of intervention concept study as desirable by participants were also retained alongside suggested changes (see Section 6.3.4). The consultation also included screening for text messaging appropriateness, set-up on the Simple Telehealth software and counselling on text message use as suggested in the original pharmacist consultation prototype in the concept co-design study.

7.2.3 Patient information leaflet for the intervention

Based on feedback in the co-design of intervention concept study, the PIL for the TIMELY intervention was split into two documents. The first document was designed to advertise the intervention to patients. This was distributed alongside the recruitment materials for this study. The second document was designed for those receiving text messages from Alice. In addition to retaining the aspects participants liked about the PIL and changes suggested from the co-design of intervention concept study (see Section 6.3.3), information was added to explain the use of MTs (see Section 7.1.5) as the system for medication monitoring. A copy of both PILs is available in Table 23.

7.3 Modified diary-interview method to gather feedback on delivery of the TIMELY intervention with patients

The HCD framework by IDEO.org suggests the use of 'live' prototyping as a way of exploring how designs may operate in the 'real' world (see Section 4.5). However, there is no guidance on methods for collecting data. To gather feedback on the live prototype a diary-interview method [316] was chosen as a starting point. The use of a diary aimed to reduce recall bias and a semi-structured interview provided the flexibility to explore a range of aspects of intervention delivery. The interview questioning was also supported by some initial analysis of patient interactions with Alice using data captured using the text messaging software and completion of the personalisation questionnaire. This approach therefore facilitated an exploration of intervention delivery acceptability, how the intervention may work to support medication-taking and how patient engagement with text messaging with Alice was supported.

Diary interviews as a method[316] allow participants to act as both observer and informant about the intervention. Whilst completing a diary of observations, the participant can capture data in real time as events and experiences of participating in the intervention unfold in real time. The interview can then be used as a way of further exploring data captured within the diary and the participant switches to the role of informant. New ideas can then also be explored with the participant in this role. Diary interviews were chosen as a starting point to gather feedback in this study because they reduce recall bias which may have occurred if interviews only were used at the end of the two-week period of text messaging. Keeping a diary also framed participants as partners in the design process by asking them to observe and provide feedback rather than be passive recipients of the intervention. However, in addition to a diary, data from the Simple Telehealth software captured from participant interactions with Alice, and data collected from the completion of personalisation questionnaires for delivery of the live prototype were also used to inform discussions in the

semi-structured interviews. These data sources also acted as point of triangulation during the analysis of the interview transcripts.

7.3.1 Participants

The aim was to recruit participants reflective of those receiving the intervention if delivered in a future NHS service, following the HCD framework on live prototyping[163] (pp. 135).

7.3.1.1 Inclusion criteria

- Patients who own and use a mobile phone
- Have at least one of the included long-term conditions:
    - T2DM (controlled with oral medication)
    - High blood pressure
    - IHD
    - Heart failure
    - COPD
    - Asthma
    - Chronic pain
    - Depression
- 18 years of age or older
- Are able to understand, read, write and speak English
- They are willing to participate

There were no additional exclusion criteria.

7.3.1.2 Sampling

A convenience sampling approach was used. As the aim was just to gather feedback from people who would be willing to receive the intervention and provide the information needed to further refine the intervention. The target sample size was ten patients.

7.3.1.3 Participant recruitment

Patients were recruited using the PCPI group hosted at the University of Sunderland. An email containing an invitation letter, participant information sheet and consent form were emailed via the academic lead for the group. Potential participants were directed to contact GD directly to ask any questions and book in an appointment for the enablement consultation. Invitations were also sent out to participants of the co-design of intervention concept study who had expressed an interest in participating in this study. Written consent was obtained in the face-to-face appointment before the enablement consultation. Verbal consent was also obtained prior to the follow-up interview. Participants had the option to opt out of text messages at any point. Materials which supported the recruitment and consent process can be found in Appendices 21-23.

7.3.2 Diary-interviews

Diary-interviews are a standard method which combine use of a participant diary with semi-structured interviews[316]. In this study, diaries were also supplemented with initial data analysis from the personalisation questionnaire and data generated in the Simple Telehealth software to support discussion in semi-structured interviews with patients.

7.3.2.1 Diary data collection

Participants were provided with a diary template aligned with the diary-interview method[316] (extract available in Appendix 24). Participants were directed to record feedback on the enablement consultation and the text messages. Participants were asked to bring their completed diary to the follow-up interview for discussion.

7.3.2.2 Personalisation questionnaire data collection

In addition to personalising text message content, the questionnaire also supported the semi-structured interviews. The personalisation questionnaire captured data on medication

timings, long-term conditions, and availability of home monitoring equipment and if the patient had chosen to receive reminder text messages. The ‘pharmacy completion’ section also contained data on the calculation of medication times.

7.3.2.3 Simple Telehealth data collection

Patients’ interactions with Alice were evaluated on the Simple Telehealth system where possible prior to semi-structured interviews. This was to identify any issues that had occurred such as problems with replies or technical bugs. Questions about this were then incorporated into the semi-structured interviews. For example, where participants had received a request for a response from Alice but hadn’t replied, I added this to the semi-structured interview topic guide to explore why they hadn’t replied. An example of the ‘Messages’ screen on the Simple Telehealth software which was used to collect this data can be found in Figure 27.

7.3.2.4 Semi-structured interview data collection

Semi-structured interviews were arranged at the first appointment to take place shortly after the last text message was delivered wherever possible. Each interview was structured using a topic guide. The topic guide prompted participants to initially talk through comments made in diaries. Additional topics included any home monitoring the patient had completed, any non-intervention long-term conditions the patient had (using data from the personalisation questionnaire) and their general thoughts on the intervention. A copy of the generic starting topic guide is available in Appendix 25.

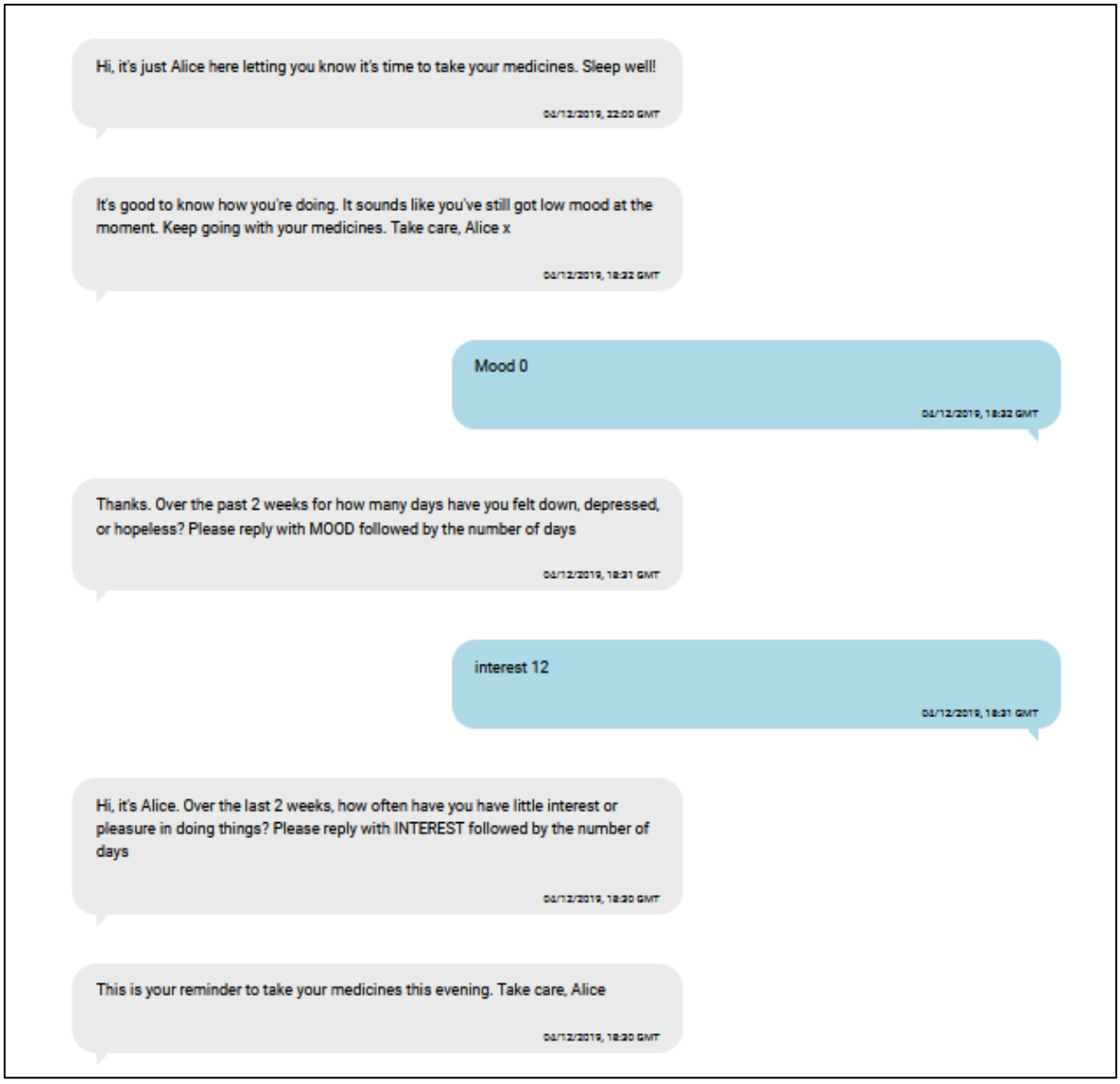


Figure 27 Example 'Messages' screen in the Simple Telehealth software used to collect data on patient interactions with Alice during the live simulation

The topic guide for interviews evolved as part of an iterative process. One of the first participants interviewed had experience of another of the long-term conditions included in TIMELY although was not receiving medication for this. Following discussion of the starting questions in the topic guide, the participant agreed to review messages for this long-term condition. This was done using paper copies of the text message protocols. Another participant received only one text message over the two weeks, so the interview questions were expanded to gather feedback on other text messages in the protocol they would have received if the simulation had continued for 12 weeks. Reviewing a paper copy of either the

remaining text messages that would be due to be sent to the participant, or an alternative protocol, was included in subsequent interviews as part of an iterative process. This included evaluation of the flow diagrams for feedback on medicine effectiveness as only baseline responses were received during the short two-week simulation. The overall length of interviews as set out in the original participant information sheet was not breached when incorporating these additional elements. All interviews were audio recorded and transcribed verbatim prior to analysis.

7.3.2.5 Diary-Interview data analysis for intervention acceptability

Both Framework approach[290] and realistic evaluation[142] analysis (see Section 4.3) were performed using data from the semi-structured interviews and complemented by data from the Simple Telehealth system and personalisation questionnaires. Initially, Framework approach was used deductively by identifying which aspects of the intervention participants liked and what changes they had identified. This deductive framework included codes for the elements of the live prototype to which the data related: the PIL, enablement consultation or text messages, and whether the data represented an aspect that the participants liked or suggested change. The specific elements which were liked or suggest changes were then inductively coded.

Following this initial framework analysis, each desirable aspect or change was evaluated to consider how it contributed to overall understanding of the intervention. This could be one of three potential strands:

- Intelligence about the acceptability of intervention delivery for patients
- How the intervention worked to support medication-taking
- Factors which affected patient engagement in text messaging with Alice

Aspects relating to the acceptability of intervention delivery were first themed together and summarised. The results of this analysis are available in Section 7.4. Analysis was facilitated by NVivo 12[224].

7.3.2.6 Diary-Interview data analysis to develop a third iteration of a programme theory for how the TIMELY intervention supports medication-taking

To examine the data for how the TIMELY intervention may work to support medication-taking, a realist analysis was conducted. This started by using the identified changes and aspects participants liked as identified using Framework approach[290]. Each change was coded for whether it provided intelligence about outcomes, mechanisms and/or contexts about how the TIMELY intervention may work to support medication-taking. In some cases, changes or aspects participants liked contained complete context-mechanism-outcome configurations. Transcripts, diaries, Simple Telehealth software data and the personalisation questionnaires were then used to systematically code outcomes, mechanisms and contexts relating to changes in medication-taking behaviour.

Medication-taking outcomes were coded where patients self-reported either actual changes during the intervention or suggested that the intervention had potential to change their behaviour if the intervention had continued. Outcomes considered included medication adherence, clinical changes, motivation to take medication and perceived capability to take medicines as described in interview transcripts.

Following change in any outcomes, mechanisms which could have affected these outcomes were coded. Coding captured potential BCT delivery and format of delivery (personalisation questionnaire, enablement consultation or text message). Mechanism coding was supported by the second iteration programme theory from the narrative synthesis systematic review (see Figure 12), the BCTs which had been attributed to text messages in library

development and patient discussions informed by the BCW. Data from the personalisation questionnaire such as BMQ scores were also used to support identification of potential mechanisms.

Finally, contextual factors were coded which seemed to affect whether mechanisms for the intervention fired. This was done by comparing relationships between mechanism delivery and outcomes between different participants and identifying differences in context. This was done using data contained within transcripts, data gathered through text messaging and personalisation questionnaires. For example, participants who seemed to have well controlled hypertension based on blood pressure measurements reported in text messages, were coded as having well controlled long-term conditions as a context for performing the behaviour taking medication. Data from personalisation questionnaires facilitated coding of participants with multiple long-term conditions where this data did not appear within the transcripts for the interviews. Codes relating to context were applied inductively with no *a priori* assumptions.

Contemporaneous notes were made during this analysis to keep track of outcomes, mechanisms and contexts, and potential configurations which were identified during the analysis. Where potential configurations were identified, they were tested across the data to see if these could be supported or refuted by data from other participants. This led to the generation of multiple context-mechanism-outcome (CMO) statements. Where a CMO was supported with data from more than one participant it was included within the third iteration programme theory for how the TIMELY intervention may work to support medication-taking. The results from this analysis are presented in Section 7.4.3. Analysis was supported by NVivo 12[224].

7.3.2.7 Diary-Interview data analysis to develop a new programme theory for how TIMELY supports patient engagement with automated two-way text messaging with Alice

A similar realistic evaluation analysis process was undertaken to develop an initial programme theory for how the TIMELY intervention supports patient engagement with two-way automated text messaging with Alice. Starting with the aspects that patients liked about the intervention and the suggested changes identified in the Framework analysis, each code was evaluated for potential outcomes, mechanisms, contexts and configurations of these relating to patient engagement.

Outcomes of patient engagement included performing the behaviours of reading and/or replying to text messages from Alice. The reading of text messages was coded in interview transcripts as the Simple Telehealth software does not capture if messages are read by patients. However, replies to text messages could be tracked using the software and this was analysed for exploration in the semi-structured interviews.

Mechanisms for engagement were coded based on accounts from participants in transcripts from the semi-structured interviews and by considering the functions of the intervention components developed for the live simulation (enablement consultation, personalisation questionnaire, patient information leaflet). Mechanisms were then coded based on how Capability, Opportunity or Motivation for reading or replying to text messages seemed to be affected during the intervention. Individual BCTs however were not formally coded during this analysis.

The main context explored for patient engagement was that of a theorised future community pharmacy service. However, patient level contexts were also coded based on interview transcripts and the personalisation questionnaire, text message protocol selection, and whether patients had opted to receive reminders for example.

Whether patients seemed to engage in the intervention or not as an outcome was used as the starting point for this analysis. Then the analysis focussed on finding mechanisms and/or contexts which seemed to affect engagement by comparing this outcome between participants and the contexts and mechanisms which had been coded. Potential context-mechanism-outcome configurations were created using contemporaneous notes of the analysis and then tested across the data. Again, those configurations which were grounded in data from more than one participant were included in a new initial programme theory for how the TIMELY intervention seems to support patient engagement with automated two-way text messaging with Alice. The findings from this analysis and a diagram of this programme theory can be found in Section 7.4.4. Analysis was facilitated by NVivo 12[224].

7.3.3 Ethics and governance approvals

This study underwent University of Sunderland Research Ethics Committee approval only as it did not involve either NHS staff or patients (Reference number: 005298). The ethical approval letter can be found in Appendix 26. Patient participants were provided with a £20 gift voucher to thank them for their participation in the study, and this was given to participants in the follow-up interview.

7.4 Results of the intervention delivery with patients

Eight patients took part in the live simulation of intervention delivery and participated in semi-structured interviews between 21st November and 16th December 2019. Interview duration ranged from 17 minutes to 36 minutes with an average of 27 minutes. The following results section starts with a description of the patient characteristics. This is followed by the results of the acceptability analysis for the TIMELY intervention from the perspectives of patients who received the live prototype. The results exploring how the TIMELY intervention may work to support medication-taking as an outcome and the behavioural mechanisms and contexts which seem to affect this are then presented. The findings which support the

development of a new realist programme theory for how the intervention may support patient engagement with Alice are contained in the final part of this section.

7.4.1 Participant characteristics

A summary of characteristics for the patients who participated in the live prototyping study can be found in Table 24. The average age of the eight participants was 61 years (range 44-72) and most were female (63%). Most participants had a twice daily schedule for their medicines and were taking an average of 8 Medication Times (see Section 7.1.6) ranging from 2 to 19 Medication Times (MTs). With the participants recruited, the text message library was tested for six out of the eight long-term conditions included in the TIMELY intervention. Chronic pain and asthma were present in three patients, two patients were available to test the depression, hypertension and T2DM messages and one patient had IHD. This leaves just the COPD and heart failure text messaging protocols untested. Six patients had additional long-term conditions which were not covered by the long-term specific messages but were included as part of the MTs calculation. Data from the personalisation questionnaire also provides some information about the perceptions that the participating patients had about their medicines.

Scores for perceived concerns about medication was the most varied amongst the sample, with an average concerns score from the BMQ of 14 (Range 10-20). Necessity score from the BMQ was quite high amongst the sample with an average of 21 (Range 15-25). All participants had a positive Necessity-Concerns Differential indicating that perceptions of need outweighed perceived concerns about medicines for all participants in the sample. There were also high scores for feeling that medicines worked using the feedback on medicines effectiveness score with an average score of 9 (range 8-10). The sample also seemed to have a relatively strong habit for medicines-taking with an average Habit Strength of 15 (Range 10– 19) which suggests good medication adherence.

The messages that participants received during the live prototype can be found in Table 25. Around half of the participants (63%) opted to receive text message prompts to support their medicines-taking during their trial of the intervention. Those receiving reminders received significantly more messages from Alice, with LP2 receiving a total of 102 messages, having opted to receive text message prompts for a five times daily dosing schedule. There were a range of text message protocol types allocated. Two patients underwent medication monitoring without feedback on an intermittent schedule and four patients were asked about weekly medication adherence as part of the intervention.

7.4.2 Intervention delivery patient acceptability

The results of the Framework analysis relating to patient acceptability for the delivery of the TIMELY intervention are presented below. These are organised thematically.

7.4.2.1 Enablement consultation

Participants were very complimentary of the approach taken for reviewing medicines in the enablement consultation. Participants felt that the consultation was a good opportunity to build a rapport between the patient and the pharmacist, but a couple of participants mentioned that it was important that the pharmacist was seeking to understand the patients' experience of medicines-taking. For example, LP1 used a 'spiking' regimen for her pain medication and felt that this should have been more explicitly explored as she recognised it was an unusual way to use pain medication.

"I know it's unusual so I would like the pharmacist to understand that it is unusual."
LP1

Another participant had a high concerns score for medication and seemed to prefer to minimise use of medicines. This seemed to be an important value around medicines that she wanted the pharmacist to understand.

"I'm trying to build on my muscle memory and doing stretches and suchlike to alleviate the joint pain. So I'm trying another method."

LP2

The changes that were suggested by participants related more to the consultation being an opportunity to prepare participants for interacting with Alice, rather than the medication review itself and will be covered in the engagement with text messaging (outcome) section of the results.

7.4.2.2 Frequency of communication

The frequency at which messages were received and replies requested felt about right to all participants. Making the text message prompts optional meant that even those receiving a large volume of messages felt that this was right because they had specifically requested them. The fact that the prompts didn't require a response may have increased their acceptability where patients already had a good habit and they acted more as reassurance.

"It's not a problem just looking at a text with a short message and you don't have to reply."

LP4

Table 24 Participant characteristics for TIMELY intervention co-design of intervention delivery study

Participant ID	Gender	Age	Medication Schedule	Medication Times	Long-term conditions in TIMELY (Not in TIMELY)	Concerns Score	Necessity Score	Necessity-concerns differential	Feedback about Medicines Score	Habit Strength Score
LP1	Female	54	Twice daily	5	Chronic Pain (Depression without medicines)	20	20	0	8	19
LP2	Female	56	Five times daily	17	Chronic Pain (Parkinson's Disease)	16	24	8	10	10
LP3	Female	66	Twice daily	3	Asthma (Chronic eczema, allergies)	11	25	14	10	15
LP4	Male	72	Twice daily	7	Depression Hypertension Ischaemic Heart Disease (Osteoarthritis)	10	21	11	8	18
LP5	Female	72	Twice daily	8	Asthma (Hypothyroidism, gastro-oesophageal reflux disease)	16	20	4	10	16
LP6	Female	44	Twice daily	2	Asthma	14	15	1	8	8
LP7	Male	63	Five times daily	17	Chronic Pain Depression Hypertension Type 2 Diabetes (Prostate cancer, anxiety)	13	21	8	9	16
LP8	Male	62	Twice daily	6	Type 2 Diabetes	11	21	10	9	16

Table 25 Text message protocols for participants in the patient co-design of intervention delivery study

Participant ID	Medication reminders requested?	Long-term condition text message protocol name	Medication monitoring text message protocol	No. messages sent during 2-week period	No. messages received during 2-week period
LP1	No	Introducing Need	None	3	1
LP2	Yes	Providing Feedback	None	102	8
LP3	No	Creating a habit	Weekly	15	6
LP4	Yes	Creating a habit	Weekly	42	5
LP5	No	Establishing need	Intermittent daily without feedback	8	3
LP6	Yes	Establishing need	Intermittent daily without feedback	36	2
LP7	Yes	Creating a habit	Weekly	88	8
LP8	Yes	Creating a habit	Weekly	40	4

7.4.2.3 Tailoring of text messages

There were no comments raised by participants about the personalisation questionnaire itself. However, during each interview, what the personalisation questionnaire had revealed about medication perceptions was explained to each participant to explore if these results resonated with their subjective perceptions. In all cases, patient participants agreed that their calculated concerns, necessity, belief about medicines effectiveness, and habit strength categories reflected their current perceptions about their medicines.

The interviews also provided an opportunity to explore whether participants felt that the text messages that they had received or would have received in the 12-week version of the intervention, felt appropriate to them based on these perceptions. This was done using printed examples from the different text message protocols which were available in the interviews (see section 7.1).

In most cases, participants felt that the text messages they received reflected their current needs in relation to information about their medicines. However, there did seem to be an issue around patient participants who had relatively high concerns scores (LP1, LP2 and LP5). Using the necessity-concerns differential to determine selection of the text message protocol (instead of the raw scores) resulted in none of these participants receiving messages to reduce concerns. However, when explored, all three participants said that they preferred the concerns messages.

"They would have suited me one hundred per cent. I like all of them [the addressing concerns messages]."

LP1

This suggests that using the concerns score, rather than the necessity-concerns differential may offer a better way of selecting text message protocols.

7.4.2.4 Text message content

Most participants were positive about the use of Alice as a persona for the text message delivery.

> *"Even though I knew it was a computer but it was in the different messages and I thought, oh that's lovely."*
> *LP2*

Participants were generally very happy with the content of their text messages from Alice. One participant commented on the variety of the prompt messages and the style used.

> *"…it's nice that you put little bits of, 'Hope you had a nice day', and all that."*
> *LP8*

Although one participant receiving text message prompts didn't actually read the message, the receipt of the message from Alice was enough to act as the reminder, so the acceptability of the text message content wasn't as important.

> *"I wasn't really concerned about the wording because I knew it was just serving as a reminder."*
> *LP6*

The only message that one participant was not sure about was a concerns message for depression which told patients that it was up to them to decide whether their antidepressant was working for them. LP1 highlighted that this message might be inappropriate for patients actively suffering from depression, because decision making can be difficult and the message needed to be more supportive.

> *"Because when you're in that black space, you don't want to make decisions. [Reads message] 'It's up to you to decide whether or not the anti-depressant has more benefits than the side-effects.' That would be frightening to me. And I know I would've when I was in that, because then I would be like, oh God, so do I take it or should I not?"*
> *LP1*

Six out of the eight participants received medication monitoring, which allowed for the testing of acceptability for this process. None of the participants raised any concerns about sending

information about their medication-taking. Two participants received a generic response from Alice without feedback. In both cases participants did not seem to have strong views about the response they got.

"That [text message just saying that Alice had received the information] was okay because it was short and sweet [laughter]."
LP5

Four patients received the text message protocol 'Creating a habit' which included providing feedback on medicine effectiveness for their long-term condition. Two patients were asked to take a home blood pressure monitoring reading, two were asked to take and submit a fasting blood glucose reading, one participant tested the administration of the ACT, two patients were asked about depression symptoms, one received chest pain monitoring for ischaemic heart disease and one person was asked about pain symptoms.

Patients with home blood pressure and blood glucose monitors reported using these at home and seemed happy to incorporate this activity into the TIMELY intervention. Discussing the flow diagrams using paper copies available in the interview allowed further exploration of the acceptability of medication effectiveness monitoring text messages. All patients receiving this monitoring thought it was a good idea and there were no issues raised about providing this information to Alice.

"If I had to choose I think that getting the messages about your blood pressure, your mood swings, chest pains, angina, I would like to keep those."
LP4

The results of the above analysis found that the TIMELY intervention was broadly acceptable to the patient participants included in the live prototyping study. This provides confidence that the data can also be used to explore the potential impact of the TIMELY intervention on medication-taking as an outcome and identify more patient level contextual factors which may affect this.

7.4.3 A third iteration of the realist programme theory for how the TIMELY intervention supports medication-taking

The following section describes the results for the realistic evaluation analysis (see Section 7.3.2.6) which used the data collected as part of the live prototyping study to create a third iteration of the programme theory. These results are organised into the mechanisms which seem to have been included in the TIMELY intervention and the potential contexts which may help or hinder their effect on the outcome of medication adherence.

7.4.3.1 Enablement consultation

In the second iteration of the TIMELY programme theory, the enablement consultation sought to remove physical and psychological capability barriers to taking medication, along with supporting patients to obtain medication. Feedback from patient participants suggested that the enablement consultation was successful as a mechanism to achieve this.

> *"I found [the enablement consultation] really helpful because it gave me an opportunity to talk through my medication, how I did it, when I did it etc. and if I was doing anything wrong then the pharmacist could correct me and that kind of thing."*
> *LP7*

For the three patients with asthma, inspiratory flow technique for their inhaler type was checked using an in-check dial device as part of the enablement consultation. This was also positively received. LP6 coincidently had had her inhaler type recently changed from an aerosol to a dry powder inhaler so she was trained using the appropriate inspiratory flow for the new inhaler.

> *"I think it's really important that we know that we're using [the inhaler] correctly."*
> *LP6*

In addition to checking for side-effects, one participant also suggested that the enablement consultation should consider whether patients may be self-poisoning with their medication.

> *"…[has the patient increased the dose] because it's stopped working or have I stopped taking it because of depression where I couldn't care less?"*

LP2

Patient participants did not provide any evidence of contextual factors which may affect the behavioural mechanisms included in the enablement consultation to support medication-taking.

7.4.3.2 Alice increasing reflective motivation

The main behavioural mechanism delivered using the automated two-way text messaging with Alice is to increase patients' reflective motivation for taking medication, also highlighted in the systematic review (see Section 5.4.2.1). In this study, most of the data related to the delivery of the BCT 'Feedback on the outcomes of behaviour'. Patient participants reported that when they received a positive response from Alice about outcome monitoring, this provided them with reassurance.

> *"…so if you've got a blood pressure monitor at home and Alice asks you to send a reading in and it's okay, you know your medication is working."*
>
> *LP4*

The benefit of communicating the result of self-testing also seemed to be present even if self-testing was something that a patient was already doing as part of their self-care. However, this reassurance also seemed to be connected to the context of Alice being linked to a community pharmacist who could also see the results and that these outcomes had good sensitivity for detecting problems.

> *"If for some reason I had stopped taking that medication and my mood had changed, obviously that would have been picked up on that score, wouldn't it?"*
>
> *LP4*

Reflective motivation could also be influenced by delivering the BCT 'Information about health consequences' around the expected beneficial effects of taking medication. Some participants said that this had increased their motivation to take medicines, in particular a

message relating to chronic pain which seemed to give participants 'permission' to use the medicines that they had been prescribed.

"Psychologically it was like, oh, somebody is aware that… I've got them to take. Why don't I take them? It was just a psychological boost."
LP2

Of those participants with high concerns scores, there was a feeling that providing the BCT 'Information about health consequences' for side effects was a helpful inclusion into the intervention.

"I think this is interesting because nobody told us about muscle shakes before and things, so this is quite helpful."
LP5

Another included BCT to increase reflective motivation was 'Credible Source', however one participant wasn't sure that they would be persuaded by the use of Asthma UK for this.

"Like [text message] number three, 'nurses at Asthma UK…' I don't know, but for me that might not be necessary."
LP6

7.4.3.3 Alice increasing automatic motivation

Habit formation is a strong predictor of medication-taking (see Section 5.4.2.2), and so another mechanism for improving medication-taking is to support patients to increase habit strength. Data from the semi-structured interviews on this mostly related to the delivery of the 'Prompts/ Cues' BCT by Alice using medication reminders personalised to the patient participants' medication regime. Those receiving text message prompts found them very helpful and, in some instances, it had prompted participants to take their medication when they had missed it.

"Sometimes when you're doing something you lose track of time, so from that point of view it was good, so having that little prompt does help."
LP8

Prompts seemed to be particularly helpful for participants who seemed to have a busy lifestyle and worked even if the participant didn't hear the message 'live' as it was still on their phone when they went to check it.

"…because I went to bed later than half-ten, there would be times that I've just gone to brush my teeth and just gone to bed and then just forgotten about [the inhaler]. But because it [the text message] was there I still took it."

LP6

One suggested change to the prompts was to schedule them for 10 minutes before a patient would normally take their medicines. This was due to potential delays to messages and was particularly important for the patient with Parkinson's Disease who knew that the timing of the doses was important.

"…because I have to take my medications spot on time, so by the time I've thought, right that's Alice, got my bag, tried to find where my medication is and then taken it, I was delayed in any case. So yeah, about five/ten minutes earlier would be great."

LP2

The use of Prompts/ Cues was helpful to some participants who had high habit strength scores, particularly for lunchtime and evening doses.

"I found the whole system worked well and there were times when if I hadn't had Alice reminding me, I probably would have forgotten, gone home, and thought, 'I didn't take my lunchtime pills'."

LP7

Of those who did not opt to receive reminders, one reason was because Prompts/ cues were seen to be less helpful. For example, those with significant chronic pain, as the return of the pain symptom acted as a prompt for medication in of itself. This was also true for the patient with severe allergies, who reported never missing a dose of their antihistamines. This could suggest that medicines with quicker onset used to treat more symptom dominated conditions could benefit less from the 'Prompts/cues' BCT.

"With pain, pain is the reminder."

LP1

But even those with conditions with a significant symptomatic component, if there was a gap between administration and the effect, there was still a temptation to delay or miss doses, even though they knew that there would be negative consequences and, in these cases, the Prompt/cue acted as an important reminder.

> *"I thought [Alice] was great because like I say, I have to be quite specific about taking my medication and it was a fabulous reminder. Because sometimes I'm a bit naughty and I just go by the feel of my body."*
>
> *LP2*

Another participant who did not opt to receive Prompts/cues said that they felt they had a good routine at home with good support, so did not think that the reminders would offer any additional benefit.

> *"I know people who say, 'Do you know, I can't remember if I took so and so this morning', or, 'I didn't take my medication this morning', and this is going through the day and I think, well, because the way [me and my husband] take [our medicines], I don't have that problem, which to me is the more helpful [support for taking my medication]."*
>
> *LP5*

The other strategy included in Alice to promote habit formation was to monitor patients' medication-taking to draw more attention to their performance and increase their motivation to do this better. The effect of this mechanism seemed to be particularly prominent where participants were open about their poor medication-taking performance. In this study this was LP3 and LP6 who also had slightly lower scores for habit strength for taking medication. LP3 hadn't opted to receive reminders but found that being asked by Alice about their medication-taking did get them reflecting on their adherence.

> *"…[the messages were] just enough to keep you aware and just thinking ah ah I haven't taken it."*
>
> *LP3*

This reflection could also be seen in the interview with LP7 when asked how frequent they thought the medication monitoring should be.

"Well, I don't think I'm that bad to need [medication monitoring] weekly. But then I think in a week I probably would miss maybe a third – I'm not sure. I don't think I'm as bad as fifty percent."

LP7

During the interviews, the feedback on behaviour mechanism was also explored, including the use of the 'Social reward' BCT. Some participants did like this aspect of the intervention.

"Psychologically you want to have praise because [taking medicines is] so mundane…"

LP2

However, this seemed to depend on what the patients' attitude was towards Alice. LP2 had a lot of communication with Alice due to the large number of reminders received during the two-week period. In the interview, the participant talked very affectionately about Alice even though they knew the text messages were automated. Other participants said that they wouldn't have paid much attention to the 'Social reward' BCT as they knew it was automated.

"I wouldn't have paid any attention…Because it's automated."

LP6

7.4.3.4 Alice addressing physical opportunity barriers

In addition to the mechanisms already included within Alice, one participant also spoke quite passionately that Alice should also provide the 'Prompts/cues' BCT for patients to order their medicines. The participant, LP7, found that keeping on top of their medicines supply was an important barrier to achieving good medication adherence and felt that prescription ordering reminders would be a helpful addition.

"I have a vast amount of different kinds of medication and I'm ordering them at different times through the month… But if I had a text message saying, 'today, you must order your lisinopril' or whatever, that would be incredibly helpful"

LP7

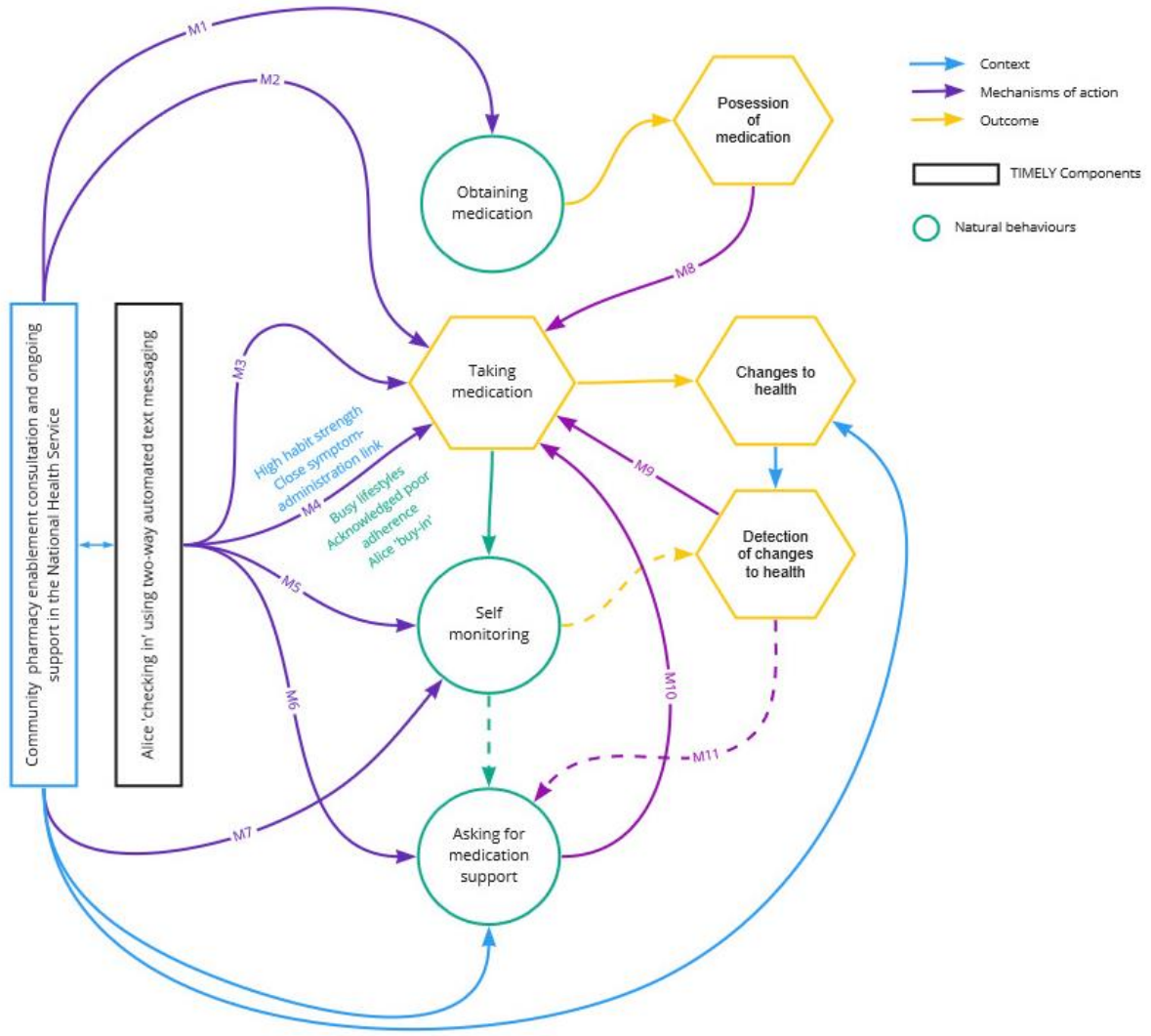
Overall, there seemed value in combining text message types. Regular communication from Alice seemed to keep taking medication on patients' agenda and let them know that

‘someone’ was interested in how they were getting on. Even if this someone was automated. This seemed to be somewhat independent of the content or intended behavioural mechanism contained within the messages, and that the communication felt meaningful to the participants seemed to be more important.

“You felt somebody was looking out for you, if that makes sense?”
LP4

This over-arching mechanism is called ‘Alice checking in’. It incorporates all the behavioural mechanisms and highlights the importance of the Alice persona as part of their delivery. When comparing which participants seemed to benefit most from this mechanism, it seemed that this was most appreciated by patients with a higher treatment burden, those who either had multiple long-term conditions or who took medicines several times a day. As designing the research aimed to design an intervention for multimorbidity, this finding is encouraging. There also seemed to be more appreciation of this in participants with depression. This mechanism and new contexts were added to a third iteration for a programme theory for how the TIMELY intervention works for future exploration (see Figure 28).

Whether participants felt that the TIMELY intervention worked for them (or not), all could see the potential value of the intervention to others. This resulted in a lot of suggestions for how to improve the delivery of the intervention in the Framework analysis. However, it quickly became clear that engagement with Alice was an outcome which warranted separate analysis.



Mechanisms key

M1: Removal of physical and psychological capability barriers to obtaining medication

M2: Removal of physical and psychological capability barriers

M3: Providing information about health concequences and 'credible source to improve reflective motvation for taking medication

M4: Prompts/cues and medication monitoring to improve automatic motivation for medication taking

M5: Prompting patients to monitor health and communicate this

M6: Prompting patients to see k support from the pharmacy when they need it

M7: Removes physical and psychological capability barriers to self-testing using point-of-care testing equipment

M8: Removal of the physical opportunity barrier to medication taking

M9: Providing feedback on the outcomes of medication taking to increase reflective motivation of taking medication

M10: Problem solving between patients and pharmacists to remove barriers to medication taking and/or deprescribing of medicines

M11: Prompting patients to ask for support if their self-monitoring indicates problems

Figure 28 Third iteration of a programme theory for the TIMELY intervention following live simulation study with patients

7.4.4 Development of realist programme theory for how the TIMELY intervention supports patient engagement with text messaging using Alice

This final analysis of the data collected during the live prototyping study was used to develop a programme theory for how the TIMELY intervention worked to support patient engagement with text messaging with Alice (see Section 7.3.2.7). Data from the Simple Telehealth software showed that all messages requesting a response were at least attempted by patients. Half of these were responded to almost immediately (average time to reply 2 minutes 7 seconds) with the other half seemingly prompted by a follow-up reminder message (average time to reply 1 hour 5 minutes). Only one response was sent in the following day. The following results are organised using the BCW to describe the potential mechanisms by which the TIMELY intervention influences the behaviours of reading and replying to text messages from Alice.

7.4.4.1 Physical opportunity to engage with Alice

To engage with Alice, a patient needs a mobile phone and a good mobile phone signal which facilitates them receiving the messages in a timely way and these are physical opportunity issues. This barrier is somewhat addressed in the TIMELY intervention by virtue of its self-selecting nature. Someone is unlikely to sign up for a text messaging intervention if they do not own a mobile phone, and the TIMELY intervention is only targeted at those who own a mobile phone. Another potential physical opportunity barrier which could hinder engagement with Alice is mobile phone signal. Both physical opportunity barriers are covered as part of the personalisation questionnaire and enablement consultation. Three participants in this study used ‘pay as you go’ to pay for their mobile phone with the remaining five having a mobile phone contract which included text messages. All participants reported having a good phone signal at home. Neither of these issues were raised as barriers to engaging with Alice as part of this study.

However, having the mobile phone in the right place at the right time and on the right settings was raised by participants as a potential physical opportunity barrier to engagement. Participants will not have the opportunity to engage if they do not know that Alice has sent a message. This included leaving the phone in another room, having it on 'Aeroplane' mode which prevents a mobile phone connecting to the network, or on silent. To combat this, one participant suggested exploring normal mobile phone use with patients in the enablement consultation, so that advice could be provided.

> *"I think that's where you've got to find out what their habits are to do with their phone then. Some people have it on all the time, so that's fine. Whereas some people think [my phone should be disconnected] at bedtime."*
>
> *LP6*

And if a patient does receive a message, time to read and reply to text messages from Alice also falls into the category of a potential physical opportunity barrier to engagement. Depending on the message, a potential reply requires more or less time to respond. Each reply also has a time window in which a reply is expected. This is particularly important in the TIMELY intervention because participants were added to several text message protocols requiring replies. The Simple Telehealth software also needs to know which replies to expect so that the responses can be matched to the right algorithm and the correct reply sent back to patients. Having lots of text messaging protocols 'open' creates technical issues. Therefore, when and how long it takes participants to reply to text messages from Alice was an important physical opportunity issue to explore.

From the Simple Telehealth data and semi-structured interviews, one of the potential reasons for lack of reply to Alice was messages being sent in quick succession. On one day, LP4 had received a medication monitoring reminder at 8pm, which he did reply to, followed by a blood pressure monitoring request at 8.10pm which he missed. This seemed to be because he did not expect the two different requests so close together. Managing

expectations about when participants would need to reply to Alice and what was going to be involved came up in other scenarios too.

LP7 received monitoring messages for both type 2 diabetes and hypertension and felt that the pre-warning message used for the fasting blood glucose measurement would have been helpful for the hypertension monitoring as well. In his scenario, he received a request to take his blood pressure whilst he was out of the house.

> *"… in the evening of the eleventh, I got a reminder from Alice to say, 'in the morning you're to do your blood sugars'. Now, that was helpful. Which in a way, if maybe during the day earlier on the fifth when I was going to give my blood pressure reading, if say lunchtime when I got my reminder it also said, 'this evening sometime, can you send me your blood pressure?' And then I'd have been able to fit it in around what I was doing. Then if I hadn't sent it by the morning, in the morning she could say, 'where's your blood pressure?'"*
>
> *LP7*

This was also raised for the medication monitoring messages when the last dose of medication was taken at night. Medicines taken at night were often the last thing a patient did before going to sleep, so asking about medication-taking even just 10 minutes after the last dose meant that patients were often asleep when it was received.

The participant who received the ACT monitoring protocol also only partially completed the assessment and thought a warning about how long the text exchange was going to would be helpful.

> *"I think maybe just saying, 'I'm going to ask you two, three or whatever questions' and then people are more prepared for it."*
>
> *LP3*

7.4.4.2 Psychological capability to engage with Alice

The first potential psychological capability barrier is the basic ability to read and send text messages using a mobile phone. This is something which has been an inclusion criterion

throughout the studies as part of this research programme. Whilst there is certainly the potential that someone who owned a mobile phone could learn to do this for the purpose of starting to engage with Alice, it is not something which this intervention concentrates on.

If potential recipients of the TIMELY intervention have this basic skill, the psychological capability is knowing how to receive and send text messages to Alice specifically. As the Simple Telehealth system is automated, the replies require patients to know how to send messages that can be 'read' and responded to by the software. The first step to increase psychological capability to engage with Alice was the introduction to the intervention as part of the enablement consultation. Most participants felt that this offered a good introduction to using Alice and all participants said that they felt confident to go away and interact with Alice following the consultation.

The next tool to increase psychological capability to engage in Alice is the PIL (see Table 23). Generally, participants said that they liked the information provided and found it easy to read and understand.

> *"I liked this. It was easy to read, nicely laid out with the bullet points and suchlike. No, I liked it and it covered everything."*
>
> *LP7*

Suggested amendments to the leaflet included adding some further examples of different types of message reply, as due to the variety of messages only a small number of worked examples were included in the leaflet. A couple of participants said that they were unsure how to reply or had received error messages and so were not sure what to do next.

> *"Some of the things that I wrote, it didn't understand them and so really it would have been great if I could have seen some of the replies that you expected…"*
>
> *LP2*

One participant felt the urge to also reply to Alice with “thank you” and was unsure if this was something that they should do, so suggested including some information about texting Alice outside of what was expected for the intervention.

The final mechanism for telling patients how to engage with Alice is the text messages themselves as every message requiring a reply contains instructions on how to do this. As part of the analysis, where Alice had requested responses from participants, and whether participants had successfully provided this information or not was examined. This was then explored in the semi-structured interviews. Most participants successfully replied to messages requesting measurements for blood pressure and blood glucose with no issues. However, one participant felt that recalling mood symptoms over two weeks was probably too long for the monitoring of depression symptoms.

> *“Because I wasn’t keeping a record – like, if I was going to bed every day saying, ‘what’s my mood been like today?’ and keeping a chart or something, then I could go back to the chart and say, ‘it’s x number of days’. But because I wasn’t keeping track of how things were, then it was difficult to give an accurate answer.”*
>
> *LP7*

Where participants had most difficulty was with the medication monitoring. No patients reported any problems calculating the number of Medication Times they had missed, but they did seem to struggle finding the right ‘key word’ to structure the reply. One participant suggested removing the need for the key word TIMES so people could just reply with a number.

> *“So if all they have to do is number six and that's giving the stock reply, I think that would be more beneficial.”*
>
> *LP2*

An alternative suggestion was for Alice to recognise a more binary response such as “none”. Potentially with a follow-up question.

> *“So, if you haven’t missed anything, ‘Sorry, no medication times missed’, you know, ‘No missed medication times’, does that make sense?”*

LP8

There were also some suggestions from participants that even those who can text may find interacting with Alice more difficult, maybe if it isn't something they do routinely or feel less confident about.

"Because I think some people, especially elderly, might not know how to text very well."

LP2

Whether this group of people are those who would opt-in to receiving the TIMELY intervention, or what additional support they may need to engage is something that needs further exploration.

7.4.4.3 Reflective motivation to engage with Alice

Reflective motivation to engage with Alice seemed to act as a powerful enabler or disabler of the TIMELY mechanism to improve taking medication, 'Alice checking in'. Those participants who seemed to almost 'bond' with Alice seemed to engage more with the TIMELY intervention and have more successful outcomes. Trying to nurture this 'relationship' could therefore increase reflective motivation to engage in the intervention and make it more effective. As the intended duration of the text messaging with Alice as part of the TIMELY intervention is twelve weeks, retaining engagement for this length of time is also something which needs consideration. Whilst this live prototype lasted just two weeks, there are some hints in the data about how encouraging engagement with Alice could be optimised.

The first potentially important mechanism to encourage patients to engage with Alice was the enablement consultation. As Alice was seen as an extension of support from the pharmacist, developing rapport between the patient and the pharmacist seemed to be key to setting up future engagement with Alice.

"So if you [the pharmacist] don't know me by initial consultation [laughs], messages are not going to help."

LP1

This adds another important mechanism to the enablement consultation as a foundation against which the relationship between patients and Alice is built to support engagement with text messaging.

Motivation to engage with Alice also seemed to be linked to whether her responses felt like a good 'fit' with how patients understood their medicines and their long-term conditions. A good example of this is when two patients sent in clinical readings which resulted in advice that these measurements indicated suboptimal clinical control. In both cases, this feedback was dismissed as inaccurate as the participants considered the results to be 'normal' for them. This could affect patients' motivation to send readings to Alice and undermine the use of feedback on outcomes of behaviour as a mechanism to increase reflective motivation for taking medication.

" [Alice said] 'It is running high. Make sure you're taking your medication to keep it under control'. But actually, that's around about what it normally is for me."

LP7

There was also speculation that messages feeding back that results were suboptimal could increase medication-related anxiety.

"…with a lot of diabetics, especially older people, if you get a text saying, 'This is high', they could panic."

LP8

Therefore, the process and thresholds at which outcome measurements messages are checked and responded to needs to be carefully considered alongside the wording of the messages themselves. However, this does create a tension, because reflective motivation is likely to be increased by highlighting improvement in clinical outcomes over time, and to do

this the intervention may start from a point where patients' long-term conditions are not well controlled.

Another version of this was the timing of messages. In the instances where LP7 had been asked to send their blood pressure reading when out of the house, this resulted in frustration that Alice was almost 'nagging' them for a reading which they could not provide.

> *"…there was one evening when I got a text asking me for my blood pressure. It was six-thirty on the fifth. But I was out at a Beaver and Cub carol service. And then I got another text reminding me that I hadn't sent my blood pressure. And I felt like saying to Alice, [mock angrily] 'yes, I know, Alice, that I haven't sent my blood pressure. That's because I'm out at a carol service. I'll be home in two hours'. [Laughter]."*
>
> *LP7*

It will therefore be important that participants do have the physical opportunity and capability to engage with the text messages to ensure that their reflective motivation to engage isn't reduced by these barriers.

This example of highlighting that Alice wasn't real was also seen when patients received error messages. When the Simple Telehealth software receives a reply in an incorrect format then it sends the message "Sorry I don't understand" and this was mentioned in the semi-structured interviews.

> *"I was saying thank you and it [Alice] was like, sorry, don't understand."*
>
> *LP2*

The Simple Telehealth system has a 'catch-all' function which can be used to rectify this particular issue, but the aim should be to minimize error messages as much as possible to continue the rapport with patients over the course of the text messaging programme.

Reflective motivation to read messages seemed to be improved by the variety in messages as well as improving acceptability of the intervention.

"I liked the variety of it. That was the thing, because I looked at it and I thought, it's not the same thing, so I'm going to read this. So yes, it kept me very interested."
LP2

There was less variety in some of the text message protocols compared to others for this live prototype, but this seems to be something that will be important to include in the final version of the text message library.

Another potential influence on reflective motivation to engage with Alice seemed to be perceived severity of disease. LP6 was the best example of this. This participant had a strong perception that their asthma was 'mild'. This seemed to translate into not only suboptimal medication adherence, but a perception that the level of intervention to support an increase in medication adherence should also match this perceived severity of disease. This meant that they felt that they should receive less text messages than someone who potentially had a more 'severe' disease. This also manifested itself more subtly in the cases of LP8 and LP5 where there was a similar perception that their health was 'under control' and therefore seemed less motivated to engage with the TIMELY intervention.

The results of this analysis of engagement with Alice as an outcome allows for the generation of a new programme theory which relates only to this outcome. As this is so pivotal to the programme theory on how the TIMELY intervention may work, this could be considered as a parallel programme theory and is presented in Figure 29.

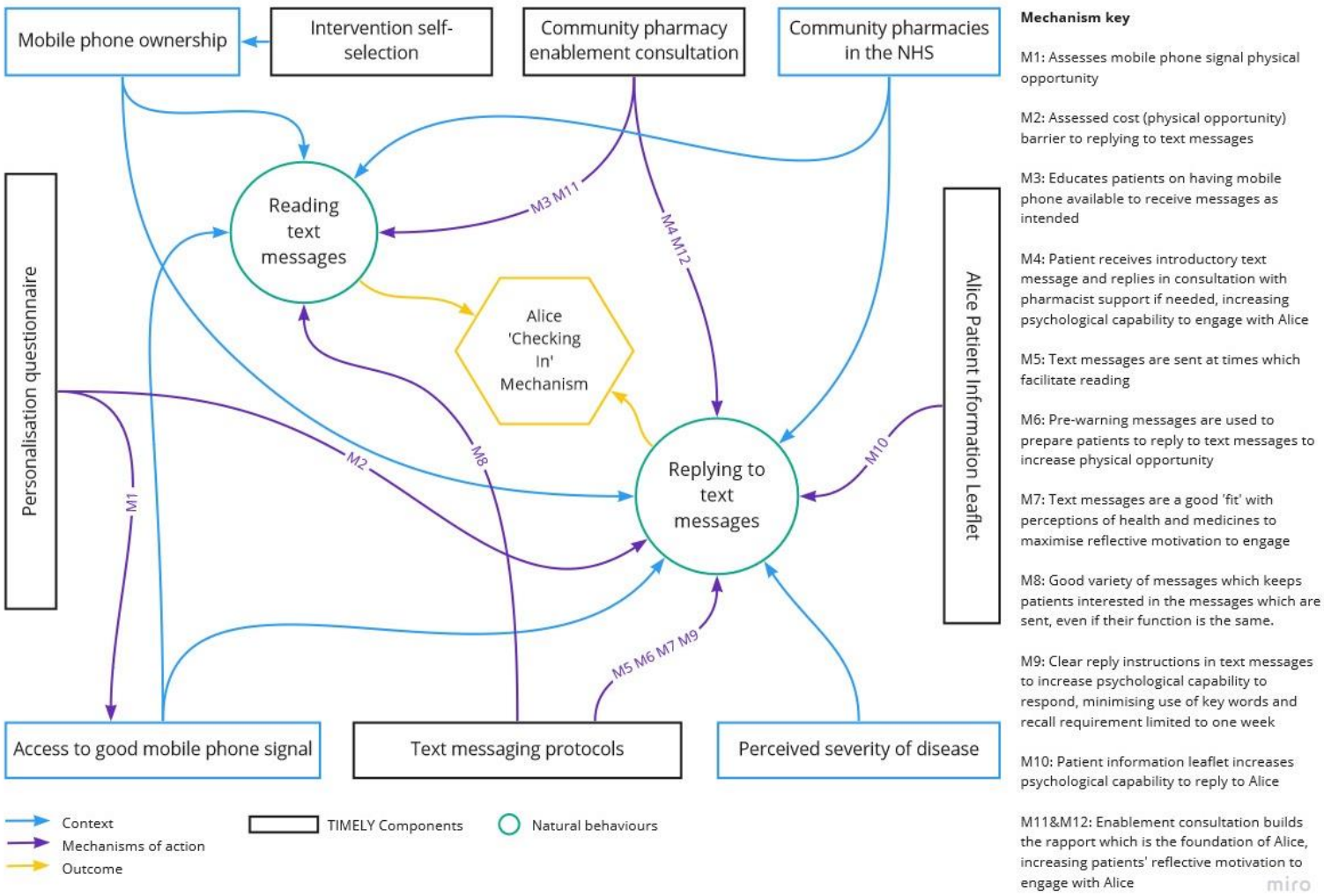


Figure 29 Realist programme theory for how the TIMELY intervention supports engagement with automated two-way text messaging with Alice

7.5 Discussion of findings from feedback on the co-design of TIMELY intervention delivery with patients

The objective of this study was to build and deliver a simulated version of the TIMELY intervention to assess its acceptability to patients and explore the potential mechanisms for how it may work, for whom and in what circumstances. This study found good acceptability for the intervention and revealed good indications that the intervention works. However, it also revealed a range of other factors which need to be considered when mobilising this intervention in the future. This included the consideration of patient contexts which may mediate the benefit of the intervention and how to optimise engagement with the automated two-way text messaging with Alice.

7.5.1 Strengths and limitations of the Diary-Interview approach

The triangulation of data sources from the Simple Telehealth software, patient diaries and personalisation questionnaire which were then incorporated into interview topic guides was a successful strategy at getting in-depth feedback from patient participants on the TIMELY intervention. The use of the diary seemed to reinforce the role of patient participants as active observers and then informants as part of the design process. This was evidenced in the large quantities of feedback received which sought to improve the intervention for delivery to patients in the future. This feedback not only provided suggestions to improve the TIMELY intervention, but also allowed for the creation of the patient engagement realist programme theory. Although there was variability in the completion of patient diaries, their use seemed to support framing of patient participants as active participants in the design process.

A major limitation was the data collection by me on the intervention that the participants knew I had designed, although there was little evidence that this had influenced their

willingness to provide constructive feedback. There were lots of useful insights obtained from this first experience of delivering the intervention with patients, many of which were unanticipated. As with the focus groups for the co-design of the intervention concept, it was made clear to participants that feedback was being actively sought and that all comments were welcome. The use of a diary may have also reinforced this. The small number of participants also means that these findings are unlikely to be transferable, and although this was not an aim of this study, it does mean that the programme theories generated remain at still an early stage of development.

7.5.2 Using a live prototyping study to gather feedback

Using a live prototyping study to explore the acceptability and outcomes of the TIMELY intervention ensured that participants' feedback was based on actual experience of receiving the intervention. Most of the components of the TIMELY intervention designed at the initial concept stage were able to be tested using this process. The only component which was not re-tested was the invitation to patients to receive the intervention in the pharmacy. The aim of the pharmacy invitation component would be to increase initial reflective motivation for patients to sign up for the TIMELY intervention. Invitations in this study were circulated via email and recruitment was less successful than hoped, recruiting only eight participants from a target of ten. This may have been due to the timing of the study as it took place in the period running up to Christmas. This study also took place in the context of a PCPI Group hosted by a university and therefore the motivation to participate may have been more linked to a desire to participate in research, rather than perceiving a benefit from the intervention itself. Therefore, the test of the patient approach and the recruitment leaflet is something which is yet to be fully evaluated.

All other elements, the personalisation questionnaire, enablement consultation and patient information leaflets, were able to be delivered as they would be in the future delivery from community pharmacies. The live prototype was also valuable at allowing the intervention to

be assessed from a delivery perspective. It allowed me to identify issues that would not otherwise have been identified until a future pilot or feasibility study. This included the detection of technical errors from patient input errors and where text message protocols 'clashed' from being 'open' simultaneously. Whilst these technical issues have been subsequently fixed, it highlighted the value of having this simulated process.

By delivering the intervention myself, I also was able to reflect on the aspects which did seem to work well. The questionnaire was easily completed by patients and was successful at gathering all the information needed to set up the relevant protocols after the consultation. Adding protocols after the patients left was also helpful as this could be done without the pressure of having the patient in the room and provided time for thorough checks. Setting up the registration during the consultation allowed patients to naturally ask any additional questions, such as whether the replies to Alice needed to be in capital letters or not. Asking patients to respond to the introductory text message in the consultation also demonstrated how quickly the system sent patient replies, seeming to provide patients with confidence in the technology before they left the room. Although the length of each consultation was not recorded, none of the consultations seemed to last longer than 15 minutes.

Analysis of the interviews also revealed the importance of the enablement consultation, and the mechanisms it delivers, both for supporting medication-taking and patient engagement with Alice. By delivering the enablement consultation myself, I was also able to reflect on how the delivery of these had gone and identify further improvements to the 'pharmacy use only' page of the personalisation questionnaire to support these mechanisms in the future. This included adding a question and counselling checklist for pharmacists to use. However, a more comprehensive analysis and further changes may have been identified if each consultation has been audio recorded and transcribed for more detailed analysis. This would be a useful addition to any future study to explore intervention fidelity when the enablement consultation is delivered by multiple pharmacists in multiple settings.

One final element of the TIMELY intervention which was not tested in this live prototype was the potential for me as the pharmacist to offer support to participants when prompted to do so by text message content. This was due to the short duration of the live prototype, and so what types of support patients ask for and how those queries may be handled by pharmacists is something which will require study in the future.

7.5.3 Reflections on development of the text message library

Key to delivering this live prototype was the development of the text message library and its construction in the Simple Telehealth software. This process was much more complex and took longer than first anticipated. This was in part due to constructing the library for the whole intervention, rather than sufficient messages to deliver the live prototype. The most challenging protocols to create were those to monitor effectiveness of medicines and those for medication monitoring.

Monitoring effectiveness of medication for some long-term conditions was straightforward, hypertension for example has recognised standards on home monitoring. Other protocols required adaption from source literature. This adaption potentially affects the validity of protocols for detecting clinical control of patients' long-term conditions. Whilst there is not an intention for the TIMELY intervention to be used for diagnosis, this limitation may affect the clinical acceptability of these protocols. Feedback from patients also indicates that there are challenges to tracking clinical effectiveness so that improvements can be recognised and encouraged, without patients feeling dispirited and potentially disengaging from the intervention.

Monitoring medication-taking is challenging in the context of polypharmacy. Several protocols were required, and a new system of measuring adherence needed to be created (MTs). Feedback from patients in this study found that the use of MTs was workable, but the frequency to ask for this measurement and what response is best provided is still something

for further exploration. No patients in this live prototype received the daily medication monitoring protocol but feedback from participants suggested that this might not be particularly welcome, especially if it was seen as disproportionate to what they felt they needed.

There was some evidence that reflecting on medication-taking over a week might be more meaningful. One option could be dynamic medication monitoring, with patients who report lower adherence receiving daily monitoring and those with better adherence monitored less frequently. This could also be done using an initial binary response suggested by one participant in the study, using “Yes” or “No” to missing any medicines before quantifying the number of medicines missed. Participants who want to receive less communications, however, may be incentivised to misrepresent their adherence in this scenario to reduce communication, thus rendering the potential behavioural mechanisms redundant.

7.5.4 Alice ‘checking in’

The analysis of feedback from patient participants enabled the programme theory for the TIMELY intervention to be further refined into a third iteration. There was good evidence that the intended behavioural mechanisms included in the intervention seem to be linked to the planned outcomes around improved motivation to take medication, and in some cases evidence of medication adherence being improved.

The suggested addition to include prescription ordering reminders by LP7 was also highlighted in the systematic review as potentially helpful (see Section 5.4.2.3). This mechanism was not initially included as where repeat prescription ordering is staggered, this would result in lots of protocols and a high burden of administration. If patients’ prescriptions could be synchronised, resulting in just one protocol for all prescriptions, this would be a viable inclusion into the intervention. This synchronisation could result in obtaining

medication being less of a barrier to taking medication and could be considered during the enablement consultation even without reminders.

The most valuable findings from this study related to the patient level contexts which seemed to mediate intervention mechanisms. Of note was the finding that those participants who seemed to 'buy in' to Alice most seemed to get the most benefit. It is unclear however whether people who 'buy in' can be identified easily. This 'buying in' is an example of anthropomorphism which seems to be particularly triggered by use of Alice as a persona as recommended in Simple Telehealth guidance[317]. Too much belief that Alice is 'real' could lead to an over-reliance on the system beyond what it can deliver, but a small amount seems to make the intervention more acceptable and effective. This 'buy in' should be explored in a larger sample as a potential context which affects the TIMELY intervention mechanisms.

Participants in this study had high positive necessity-concerns differential and habit strength scores. This suggests that the sample included a large proportion of patients with good medication adherence, and this could be linked to recruiting participants from the PCPI group at the University of Sunderland. This may have skewed the data which supported the third iteration of the realist programme theory for how the intervention supports medication-taking. However, it is more likely that the findings would be transferable to similar patients, but different contexts and mechanisms may be important with different patients. It is therefore important that the intervention is tested again using more diverse samples of patient participants.

7.5.5 Engaging with Alice

This study facilitated the creation of a new realist programme theory for how the TIMELY intervention supports patient engagement with text messaging using Alice. Ensuring that patients engage with text messaging interventions is something that has been highlighted in

other reviews[115,116,123] but the programme theory developed here provides greater insight into what may help or hinder engagement. Although most of these mechanisms had been purposefully included into the intervention design, the data from this study added to this and provided evidence that these seemed to be successful to engage patients. The important role that community pharmacy played as a context for the intervention beyond a mechanism of delivering the intervention was a key finding. This strengthens the case for the TIMELY intervention's delivery in this setting, not just for practical purposes but as a key contributor to intervention effectiveness by increasing motivation to engage with the intervention. Whilst this would also likely apply to the use of Florence in general practices, this so far has not been documented in the literature.

The programme theory also highlights the dual role of the enablement consultation not only in supporting medication-taking, but also acting as a key component to facilitating engagement with Alice. There were also data supporting the use of other intervention components for improving engagement with Alice, including the PIL for reducing psychological capability barriers, and the personalisation questionnaire to select content that felt appropriate to patients. Tailoring intervention content was also highlighted as important for automated two-way text messaging in the narrative synthesis systematic review (see Section 5.4.2.8).

The use of the BMQ[35] was found to be effective at supporting the tailoring of text messages, but using the raw scores rather than the necessity-concerns differential. This suggests that the necessity-concerns differential may mask important perceptual barriers to medication-taking and is an important finding for intervention designers seeking to use BMQ to tailor content to influence medication beliefs. However, there may also be limitations to using the BMQ. For example, where medications are used 'when required', alongside medicines for other long-term conditions, the score might also be undermined by the medicine not being

used consistently. The only long-term condition this is likely to relate to is chronic pain as all other messages target medicines which would be taken consistently.

The analysis for engagement also revealed the importance of message timing. Reminders in the live prototype were set for medication times discussed in the enablement consultation. However, long-term condition specific messages and medication monitoring were not and were instead sent at standard pre-determined times. The utility of the pre-warning messages highlighted by LP7 means that using a combination of more personalised timing and pre-warning messages may further increase physical opportunity for patients to engage in messages from Alice requiring a reply. Message variety was also something that seemed to support increased engagement with Alice. Participants noticing that the text message was different to those received before seemed to increase motivation to read the messages. Novelty has also been suggested as an important aspect for text messaging interventions by others[318].

The development of the realist programme theory for patient engagement also found that the acceptability of intervention intensity may be linked to perceived disease severity. Perceived disease severity can be linked to perceived medication necessity and therefore medication adherence, although the relationship is not always straightforward[283]. This relationship suggests that those with highest nonadherence may be the least willing to accept more intensive interventions. The current text messaging library structure for delivery suggests the highest intensity monitoring (daily) for those with the lowest adherence, but this may risk disengagement. Whilst the small sample size in this study does not prove this theory, Nelson et al.[319] did find a small relationship between low medication adherence and low engagement in their study of text messaging for diabetes. Whether perceived disease necessity and/or treatment necessity are correlated with engagement may be something to study in the future.

Chapter 8 Co-design of intervention training with community pharmacy

This chapter describes the co-design of the training to deliver the TIMELY intervention with community pharmacy staff. The aim of this study was to run a simulated training event to gain feedback on training components which could be used to prepare pharmacies to deliver the TIMELY intervention. Guidance on complex intervention development highlights the importance of planning for future intervention delivery[144] and this includes training for those who are anticipated to deliver complex interventions as part of implementation.

Chronologically, this study took place before the patient acceptability study, however this study is described here so that the reader has a better understanding of how the TIMELY intervention works, and therefore the training considerations. The slight difference that needs to be highlighted is that this study was planned still using a Medicines Use Review (MUR) rather than the enablement consultation described in Chapter 7. This means that there will be additional training needs around the enablement consultation delivery which will not be considered until the discussion section of this chapter.

8.1 Developing the simulated intervention training

The first step in this study was to develop the training for delivering the TIMELY intervention. Ensuring that professionals can use telehealth platforms has been highlighted in another study using Flo in community pharmacy[135]. Training was important to combat any misconceptions that community pharmacy teams may have about telehealth interventions as highlighted by Kayyali et al.[320]. As discussed in Chapter 2, research surrounding the implementation of the New Medicines Service (NMS) has also found that getting pharmacy teams to ‘buy-in’ to a new service is also important for successful mobilisation of an intervention[83].

In the co-design of intervention concept study (see Chapter 6), community pharmacists agreed that involving the wider pharmacy team, such as pharmacy technicians, could be a useful resource to support delivery of the TIMELY intervention in pharmacies. Therefore, in the current study, the sampling frame was extended to include pharmacy technicians as potential participants. PharmOutcomes had also been agreed as a potentially useful tool to support communication with general practice, this software is routinely used in community pharmacies for other services, so testing its use was not a priority in this study. The training designed and evaluated in this study was focussed on preparing community pharmacy teams to deliver the TIMELY intervention.

8.1.1 Applying COM-B to intervention delivery by community pharmacies

The Capability, Opportunity and Motivation for Behaviour (COM-B)[158] was introduced in Section 4.4, and has been used to both develop the intervention to support medication-taking and in the last chapter, engaging with text messaging with Alice. In this study, the COM-B model was again used, but this time for the behaviours of community pharmacy staff.

The journey map created to show the anticipated patient experience of the TIMELY intervention also captures the behaviours required by pharmacy staff to deliver the intervention (see Figure 5). These include:

- inviting patients to receive the TIMELY intervention
- performing a medication review
- selecting the most appropriate support for the patient to support medication-taking
- setting up patients and adding text message protocols using the Simple Telehealth software
- monitoring messages received from patients
- contacting patients where needed, as indicated by the message monitoring

A pharmacy assistant inviting patients to receive the TIMELY intervention was explored for its acceptability with patients as part of the co-design of intervention concept study, and as this was found to be positive, this present study sought to examine how pharmacy staff could be supported to perform this behaviour in a future implementation of the intervention. A COM-B assessment of this behaviour using guidance from the BCW[157] suggested that physical opportunity and physical capability were unlikely to be barriers, as this type of behaviour is frequently performed for other pharmacy services such as NMS. However, pharmacy staff would need to know how and who to approach (psychological capability) and would likely need to have the reflective motivation to integrate this behaviour into their working practice. These needs are also mirrored in implementation models such as Normalisation Process Theory[155]. To meet these needs, an introductory eLearning prototype was created for testing in this study. This include instructions on how to perform this behaviour (to increase psychological capability) and explaining the potential benefits of the intervention to patients (to increase reflective motivation).

Performing a medication review had already been explored as part of the co-design of intervention concept study (see Section 6.3.4) and as this mostly reflected a MUR, which was being routinely being delivered in community pharmacies at this time, this was not a target behaviour for in-depth exploration in this study. Selecting the most appropriate needs for patient from a range of options had also been deprioritised early in the intervention development study during the initial intervention scoping, to focus specifically on designing an intervention using automated two-way text messaging.

The decision to create a personalised digital intervention based on evidence from the narrative synthesis systematic review (See Section 5.4.2.8) introduced a new behaviour into the process: interpreting the personalisation questionnaire. Whilst the questionnaire and its link to intervention delivery was explored with healthcare professionals in the co-design of intervention concept study, the ability of pharmacists to administer and interpret the

questionnaire had not been explored and was therefore included as part of the present study. Linked to this, was whether pharmacists could interact with the Simple Telehealth software to select the appropriate content for patients following interpretation of the personalisation questionnaire and using the software to see messages from patients. Using the COM-B framework, a key enabler to performing these behaviours would be the psychological capability of pharmacists as both would be new activities. The good acceptability of the intervention as found in the co-design of intervention study suggested that reflective motivation would be less of a barrier to these behaviours. Physical capability was unlikely to be a barrier as these activities were mirrored in existing pharmacy services, such as NMS and over-the-counter medicine screening tools. Therefore, a pharmacy manual was created with the primary aim of meeting the psychological capability needs of pharmacists to perform these intervention behaviours.

Contacting patients as needed based on message monitoring was not considered in this study, as the aim was to create an intervention which focused more on self-management of patients and directing patients to ask for support when needed, linked to the intervention programme theory. The co-design of intervention to support delivery of the intervention (Chapter 7) which took place chronologically after the present study did suggest that this may need to be revisited if the TIMELY intervention is to be further developed.

Physical opportunity including availability of physical resources and time to deliver the intervention components was identified as a potential barrier to all delivery behaviours. Similarly, Social Opportunity, identified as a pharmacy's culture for delivering this type of intervention, would also likely be a barrier for all the identified delivery behaviours. As these factors would be determined within the pharmacy themselves and could not be easily influenced directly, a different approach was taken. A pharmacy readiness assessment tool was created which sought to highlight these as potential issues to TIMELY intervention mobilisation for consideration by a local pharmacy manager. Community pharmacy activity is

generally driven by the manager, who is also often the pharmacist and staff often take cues on their behaviour from the pharmacist as the leader. Therefore, the pharmacy readiness self-assessment tool provided prompts to encourage the development of social opportunity within the pharmacy to deliver the intervention and assess potential physical opportunity barriers. The readiness assessment tool also suggested techniques to further increase reflective motivation to deliver the intervention and all the associated behaviours. Issues such as how long it would take to perform behaviours such as interpreting the personalisation questionnaire and interacting with the Simple Telehealth software were also unknown and would be examined by simulating these activities during this study. A summary outlining which component of COM-B each element sought to tackle and which behaviour they aimed to target can be found in Table 26. The COM-B assessment led to a series of design questions to answer in this study through the development of prototypes to be used in a simulated pharmacy training session.

Table 26 Summary of pharmacy training components and their target behaviours

Training component	Target behaviour(s)	COM-B target
Introductory eLearning	Inviting patients to receive the TIMELY intervention	Reflective motivation Psychological capability
Pharmacy manual	Interpreting the TIMELY questionnaire	Psychological capability
Pharmacy manual	Setting up patients and adding text message protocols	Psychological capability
Pharmacy readiness self-assessment tool	Setting up patients and adding text message protocols	Physical opportunity
Pharmacy readiness self-assessment tool	Inviting patients to receive the TIMELY intervention	Physical opportunity Social opportunity Reflective motivation

8.2 Prototype development for simulated pharmacy training

The simulated pharmacy training session involved community pharmacy participants evaluating two static prototypes: a PowerPoint[321] for the eLearning programme and the pharmacy readiness self-assessment tool. In addition, the pharmacy manual and some supporting instructions were created to train the pharmacists on how to interpret the TIMELY

personalisation questionnaire, set up a patient on the Simple Telehealth software, and allocate the appropriate text message protocols to that patient. A copy of the prototypes can be found in Table 27.

8.2.1 eLearning

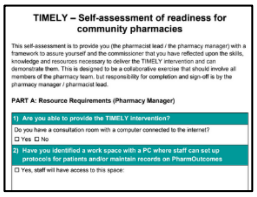
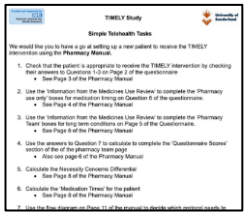
Use of eLearning systems has become increasingly prevalent amongst community pharmacy professional development, with most new initiatives supported by online learning. eLearning systems require a large amount of resource to build, therefore one low-cost way of testing eLearning ideas in advance of spending such resource is the use of a prototype which indicates the content of the eLearning programme[322].

To develop the eLearning prototype for the TIMELY intervention, a PowerPoint slide template was created which mimicked the format of the Storyline 1[323] eLearning software used at the University of Sunderland. The content was structured using the guidance in 'Developing e-learning materials applying user-centred design'[322] which encourages designers to consider learning objectives to support the planning for an e-learning resource. For the TIMELY eLearning, the objectives focused on four questions. These included:

- Why is medication adherence important?
- What is TIMELY?
- Who is TIMELY for?
- How does TIMELY work?

A mixture of content was suggested in the prototype. This included audio commentary over text (only the text on the slide was shown), short videos (indicated in the slide deck with a description) and quiz materials as suggested by the National Learning Network[322]. A draft of the eLearning in this format also received feedback from the TIMELY Steering Committee prior to finalisation. The eLearning supported delivery of the TIMELY intervention only and not any aspects of research delivery. A copy of the prototype is available in Table 27.

Table 27 Co-design of pharmacy training study with community pharmacy design questions and prototypes

Design question from experience map	Prototype to be used	Click to view prototype	Scan to view prototype
How effective is the TIMELY training (eLearning) at preparing pharmacy teams to deliver the TIMELY intervention?	eLearning slides		
Does a self-assessment tool highlight key actions to support introduction of the TIMELY intervention into community pharmacies?	Pharmacy readiness self-assessment tool		
How effective is the TIMELY pharmacy manual at supporting pharmacy staff to set up patients on the telehealth system and add the correct protocols?	Task list for simulated patient set-up on the Simple Telehealth system		
	Pharmacy Manual		
	Information about simulated patient from MUR		
	Personalisation Questionnaire for simulated patient		

8.2.2 Pharmacy readiness self-assessment tool

Recognising prior education and training of pharmacists using self-assessment tools has become increasingly common. This model is called a 'Declaration of competence'[324]. One example was the introduction of the NMS. NHS Employers produced a pre-implementation checklist which asked pharmacy managers to reflect on what actions they, and their pharmacy needed to complete to prepare for service delivery[325] (this has since been updated to reflect the decommissioning of MURs). The checklist highlighted the pre-requisites for NMS delivery outlined in the service specification, and the potential learning needs of the pharmacist delivering the intervention and the wider pharmacy team.

For the TIMELY self-assessment tool prototype, the NMS checklist was used as a template. The self-assessment tool was adapted to reflect the COM-B assessment of behaviours required to support intervention delivery. In particular, the self-assessment asked questions about physical opportunity for incorporating using the Simple Telehealth software into a MUR consultation and use of the supporting materials, as well as the potential training and development needs of the pharmacist and the wider pharmacy team. Feedback was also obtained on this prototype during a TIMELY Steering Committee Meeting prior to this study.

8.2.3 Pharmacy Manual

To support pharmacy teams to interpret the TIMELY personalisation questionnaire and interact with the Simple Telehealth software, a prototype pharmacy manual was created (see Table 27). Alongside the manual, a simulated patient case was created with a completed TIMELY personalisation questionnaire and information from a MUR (also available in Table 27). These were provided to participants to support them to use the pharmacy manual to interpret the questionnaire, including completion of the 'pharmacy only' section. Participants were then instructed to set up the simulated patient on the Simple Telehealth software. Each participant was provided with log-in details for the Simple Telehealth software and interacted with the system 'live' during the training.

The pharmacy manual used a combination of written instructions, worked examples and annotated screenshots of the Simple Telehealth software to guide users. It also contained the flow charts to select text message protocols based on the questionnaire, and tables to facilitate the calculation of Medication Times (MTs) (see Section 7.1.6). A list of ordered tasks was provided which directed participants to the relevant sections of the pharmacy manual to complete the exercises (see Table 27). Pharmacy staff used their own mobile phone number to set up the simulated patient on the system, select the appropriate text messaging protocols and personalise the number of MTs to support medication monitoring.

8.3 Focus group with modified nominal group technique method to gather feedback on the delivery of the TIMELY intervention training with community pharmacy

To explore whether the training developed would support delivery of the TIMELY intervention, it was important to gather feedback from the target audience. To observe interactions with the training components developed as well as ask participants about their experience of using the materials, the simulated training was combined with a focus group and using modified Nominal Group Technique (NGT). This would also include the collection of qualitative data and prioritise changes to the training and identification of important aspects to retain in the final training programme.

The simulated training and focus group took place at a computer suite in Sunderland off the University campus. Similar to the focus groups in the co-design of concept study, each prototype was assessed separately. This was arranged in the order which the training had been designed to be accessed by pharmacy staff. This started with the eLearning, then the set-up of a simulated patient and finishing with the pharmacy readiness self-assessment tool. Due to time restrictions, just one focus group was planned.

8.3.1 Participants

Participants for the co-design of intervention training study were any community pharmacy staff who could be involved in the delivery of the TIMELY intervention.

Inclusion criteria

- 18 years of age or older
- Currently practicing as a healthcare professional in a patient-facing role within a community pharmacy including: pharmacists, pharmacy technicians, dispensing assistants, medicines counter assistants
- Are able to understand, read, write and speak English
- They are willing to participate

There were no additional exclusion criteria.

8.3.1.1 Sampling

A convenience sample was used consisting of community pharmacy staff who agreed to participate in the study. The target sample size was 5-10 participants to try and gather a range of opinions for discussion but to be manageable in a focus group format.

8.3.1.2 Participant recruitment

The community pharmacy staff were recruited via my own professional network in North East England. Community pharmacists were approached and in addition to their participation I asked if they could also invite staff working in their own pharmacies to participate. Potential participants were emailed an invitation letter, a participant information sheet and consent form prior to the focus group (copies available in Appendix 27, Appendix 28 and Appendix 29 respectively). Potential participants were provided with my contact details to send any questions in advance of the group taking place and were informed of the date, time and location of the focus group. Consent forms were collected at the start of the

meeting and consent was also confirmed following a verbal introduction by GD before audio recording began.

8.3.2 Focus group with modified NGT

The format of the focus group with modified NGT[288] was largely the same as that for the co-design of concept acceptability study groups, with each prototype being presented and participants asked to identify characteristics that they liked about the prototype and items that they felt needed to be changed. As this was a single focus group, the ranking exercise took place in the focus group, rather than using a questionnaire following the event.

8.3.2.1 Data collection

To gather feedback, participants were asked to capture aspects of the protoypes that they liked, and aspects that they felt needed to change on post-it notes, with a different colour depending on whether the suggestion was something the participant liked, or a suggested change. These post-it notes were then added to flip-chart paper, with one flip chart for each of the prototypes. Whilst GD moved on to another prototype, the co-facilitator (NH) themed the post it notes and wrote these themes onto the flip-chart in preparation for the voting exercise.

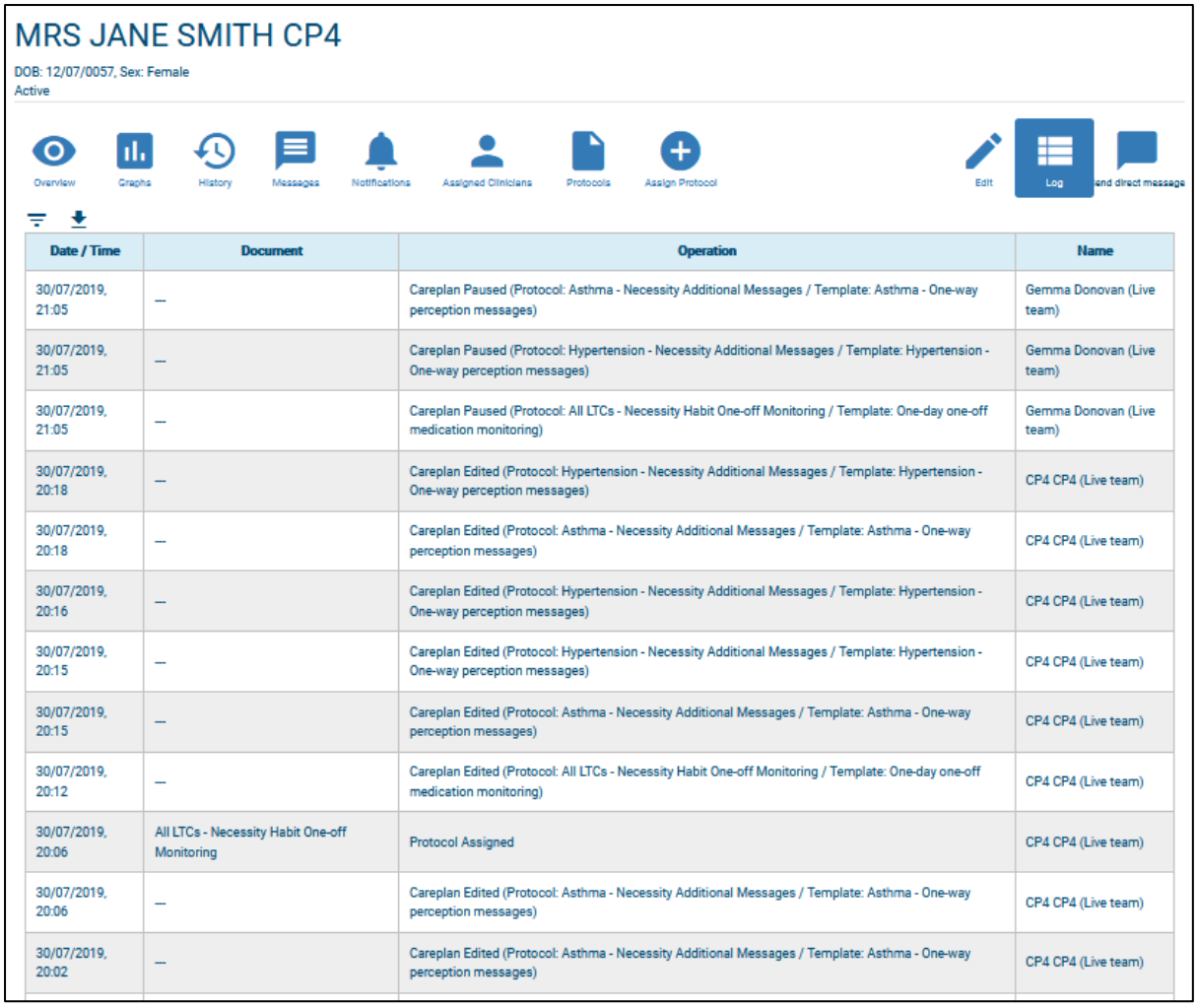
Once all the changes and desirable characteristics had been themed, participants were then asked to rank the most important aspects from 1 to 3 (one being the most important, three being the least important) for the suggested changes and liked aspects for each of the focus groups. Participants were provided with the appropriate number of pre-prepared stickers with numbers to facilitate the voting exercise. The focus groups were facilitated by use of a topic guide (see Appendix 30).

The focus group discussion was audio recorded and transcribed verbatim. Data was also generated from participants completing the 'Pharmacy use' page of the Personalisation Questionnaire as part of the training activity. This captured information on how participants had interpreted the questionnaire, for example, how many Medication Times they had calculated for the simulated patient. Participants' activity data on the Simple Telehealth software was also available in 'logs' (see Figure 30). These were used to check which text messaging protocols had been added to the patient profile created during the training. This also included protocols which were added mistakenly and removed for example, and also any amendments which were made. This provided data about how participants had interacted with the software system. Participants were also invited to annotate the eLearning slides and pharmacy readiness self-assessment tool with any questions or comments prior to the discussion during the focus group.

8.3.2.2 Data analysis

The data collected on the post-it notes, from the voting exercise and in the transcripts was triangulated as part of the data analysis. The transcripts were initially coded using Framework approach[290]. Codes were applied deductively initially for the prototype to which comments related, and whether the comment related to a change or an aspect which was desirable. Then within these categories, inductive coding was applied to identify specific suggestions. Data relating to other aspects of the intervention design were coded inductively.

As per NGT methods, each of the changes and aspects which participants liked were scored. This was done by converting ranks to a numerical value and adding these together so that each element had a total score, with a higher score indicating a higher priority.



MRS JANE SMITH CP4

DOB: 12/07/0057, Sex: Female
Active

Overview | Graphs | History | Messages | Notifications | Assigned Clinicians | Protocols | Assign Protocol | Edit | Log | Send direct message

Date / Time	Document	Operation	Name
30/07/2019, 21:05	—	Careplan Paused (Protocol: Asthma - Necessity Additional Messages / Template: Asthma - One-way perception messages)	Gemma Donovan (Live team)
30/07/2019, 21:05	—	Careplan Paused (Protocol: Hypertension - Necessity Additional Messages / Template: Hypertension - One-way perception messages)	Gemma Donovan (Live team)
30/07/2019, 21:05	—	Careplan Paused (Protocol: All LTCs - Necessity Habit One-off Monitoring / Template: One-day one-off medication monitoring)	Gemma Donovan (Live team)
30/07/2019, 20:18	—	Careplan Edited (Protocol: Hypertension - Necessity Additional Messages / Template: Hypertension - One-way perception messages)	CP4 CP4 (Live team)
30/07/2019, 20:18	—	Careplan Edited (Protocol: Asthma - Necessity Additional Messages / Template: Asthma - One-way perception messages)	CP4 CP4 (Live team)
30/07/2019, 20:16	—	Careplan Edited (Protocol: Hypertension - Necessity Additional Messages / Template: Hypertension - One-way perception messages)	CP4 CP4 (Live team)
30/07/2019, 20:15	—	Careplan Edited (Protocol: Hypertension - Necessity Additional Messages / Template: Hypertension - One-way perception messages)	CP4 CP4 (Live team)
30/07/2019, 20:15	—	Careplan Edited (Protocol: Asthma - Necessity Additional Messages / Template: Asthma - One-way perception messages)	CP4 CP4 (Live team)
30/07/2019, 20:12	—	Careplan Edited (Protocol: All LTCs - Necessity Habit One-off Monitoring / Template: One-day one-off medication monitoring)	CP4 CP4 (Live team)
30/07/2019, 20:06	All LTCs - Necessity Habit One-off Monitoring	Protocol Assigned	CP4 CP4 (Live team)
30/07/2019, 20:06	—	Careplan Edited (Protocol: Asthma - Necessity Additional Messages / Template: Asthma - One-way perception messages)	CP4 CP4 (Live team)
30/07/2019, 20:02	—	Careplan Edited (Protocol: Asthma - Necessity Additional Messages / Template: Asthma - One-way perception messages)	CP4 CP4 (Live team)

Figure 30 Example of Simple Telehealth software log data to evaluate pharmacist activity during the training simulation

The completed 'Pharmacy use only' pages on the personalisation questionnaire were checked to see if participants had correctly interpreted the questionnaire based on the simulated patient case provided. The answers annotated on the 'Pharmacy use only' page were also checked against what had been entered in the Simple Telehealth software. The time taken for pharmacists to complete the exercises and any errors which were made were also evaluated using the log created for the simulated patients by each individual participant.

8.3.3 Ethics and governance approvals

This study was approved by University of Sunderland Research Ethics Committee (Reference number 004613) and received Research Governance approval from the NHS

Health Research Authority (Reference 19/HRA/4119). Links to copies of the approval letters are available in Appendix 31 and Appendix 32. No incentives were provided to professional participants, though the focus group was catered.

8.4 Results of the intervention training delivery with community pharmacy

The simulated training event took place on 30th July 2019. Four participants attended, three of these were pharmacists and one was a pharmacy technician. Two of the pharmacists and the technician were from the same company. The event lasted 1 hour and 47 minutes. The following results are organised into feedback regarding each training element which was explored during the simulated training exercised. The results of the qualitative analysis and NGT scores are presented together to facilitate interpretation of both sets of data. These are supplemented with information from the Simple Telehealth software, personalisation questionnaires or annotations on documents where relevant.

8.4.1 eLearning

Participants were complementary about the eLearning prototype. The results of the NGT exercise are presented in Table 28. Few improvements were suggested. Participants liked the multimedia content and thought that it was an appropriate format for pharmacists delivering the intervention to access content. The eLearning was felt to be suitable for all members of the pharmacy team who might be involved in delivering the TIMELY intervention.

> *"The e-learning, I think the book's fantastic, I honestly do. I was struggling to find anything wrong with it, there's no negatives there, it's very clear."*
>
> *Community pharmacist participant*

Aspects for change included how to offer the intervention to patients who may not be motivated to sign up for the intervention but may benefit from it. There was also a suggestion to include information on how the intervention works.

Table 28 Results of the NGT Ranking Exercise for aspects participants liked for the eLearning prototype

Aspect liked	Nominal Group Technique Score
Easy to understand	6
Logical order	5
Provided good background information on medication adherence	2
Clear layout	1
Provided a good summary on the intervention process	1

The suggestion from patients in the co-design of intervention concept study to involve pharmacy delivery drivers in supporting the intervention was included in the eLearning (see Section 6.3.1), but the community pharmacist participants were not sure this was a good idea. As the NGT ranking exercise was completed after all activities were completed, most participants felt that the eLearning should be expanded to cover the simulated patient exercise rather than use of a face-to-face training event. The results of the NGT ranking exercise can be found in Table 29.

"I think most of the things we do now is online, and you kind of have more time to play around don't you? I think online training tools are much better."

Community pharmacist participant

Table 29 Results of the NGT ranking exercise for aspects to change for the eLearning prototype

Aspect for change	Nominal Group Technique Score
Examples of how to set the intervention up are needed in addition to the pharmacy manual	9
Include information on how the TIMELY intervention works	4
Not sure about the involvement of delivery drivers	3
How to explain the intervention and offer it to patients who may be 'unmotivated'	2

8.4.2 Pharmacy readiness self-assessment tool

Three participants were available to evaluate the self-assessment for implementation tool, as the focus group overran and one pharmacist participant had to leave, but this prototype was also well received. The results of the NGT ranking exercise for aspects of the tool that participants liked and suggestions for change are available in Table 30. One suggestion was to remove the tick boxes relating to each of the long-term conditions included in the study as this implied that additional learning was required to deliver the intervention:

"...am I not qualified enough because I haven't done additional learning on those individual things?"

Community pharmacist participant

Table 30 Results of the NGT ranking for the pharmacy readiness self-assessment tool

Aspect liked	Nominal Group Technique Score
A standardized/ familiar format to the tool	6
Easy to complete	4
Aspect for change	**Nominal Group Technique Score**
Including section on knowledge/ skills implies that additional learning is needed – may be better to leave a more open response rather than tick boxes	1

8.4.3 Pharmacy manual

Using the pharmacy manual to interpret the personalisation questionnaire, set up the simulated patient, allocate text messaging protocols and personalise these for the correct MTs on the Simple Telehealth software took approximately 50 minutes. Analysis of the data within the Simple Telehealth software logs indicated that the personalisation of protocols and calculation of MTs took up the bulk of this time. The Simple Telehealth logs also revealed that the participants had difficulty selecting the right protocol in the software, even though they had all successfully identified the correct text messaging protocol for the simulated patient. This difficulty was echoed in the qualitative data and NGT ranking exercise which can be found in Table 31.

"I thought the first exercise we did [interpreting the questionnaire] was more at our level really. [Laughter] It was like doing GCSEs, but then the second [adding the protocols in the Simple Telehealth software] bit was like doing the A-Levels."
Community pharmacist participant

Participants suggested that more information would be needed to support this in future training and that this process would need to be completed by more qualified staff such as the pharmacist or a technician. Although one participant suggested providing a full worked example would be helpful, another said that this might not then teach users the transferable skills to add different patients with different requirements for set-up.

Table 31 Results of the NGT ranking exercise for the pharmacy manual

Aspect liked	Nominal Group Technique Score
The pharmacy manual was easy to use and navigate	No votes
Made it easy to transfer information from the questionnaire to Simple Telehealth software	3
Good overall to guide the exercise	No votes
Aspect for change	**Nominal Group Technique Score**
Better explanation needed for calculating Medication Times	No votes
Selecting the right protocols was difficult (would need to be a pharmacist or technician doing this step)	6
Inclusion of a fully worked example in a continuous format would have been more helpful for the whole process	No votes
Adding learning into an online training tool would be helpful	4

From reviewing the documents completed as part of the workshop, I found that all participants successfully interpreted the personalisation questionnaire, however all made an error when calculating MTs which was the omission of one of the medicines in the simulated patient medication list (Atorvastatin 10mg tablets) from the calculation. This seemed to be because the participants could not link it to the diagnosis list which was available on the

information about the simulated patient from MUR which only included asthma and hypertension. On reviewing the prototype pharmacy manual, these were the instructions and so this would need to be amended part of future training.

8.4.4 Other comments

There was some discussion in the focus group unrelated to comments on the prototypes which related to the current available skill mix and capacity within community pharmacies. There were concerns that due to recent cuts to community pharmacy funding, not all pharmacies may be able to deliver the future intervention.

> *"…because we've got this funding crisis within pharmacy, so we're left with a core of really good staff, but then the types of people that we're having to recruit really, are quite low level, and this is always going to be an issue is having the right skill mix within a pharmacy now you know?"*
>
> *Community pharmacist participant*

Whilst this comment is not directly linked to the future development of training to support pharmacists to deliver the intervention, it is something that it is important to consider as part of potential future implementation of the TIMELY intervention.

8.5 Discussion of findings from the feedback on the co-design of TIMELY intervention training delivery with community pharmacy

The objective of this study was to run a simulated training event to assess how community pharmacy staff might prepare to deliver the TIMELY intervention and get feedback on the training components. The results have shown that the basic structure of the training seems to be acceptable to community pharmacy staff, however there are also some suggested changes to consider as well as some broader potential issues around delivery of the TIMELY intervention by community pharmacies which will now be considered.

8.5.1 Strengths and limitations of the focus group with modified NGT to gather community pharmacy feedback on TIMELY intervention training

The combination of a live simulation and focus group with NGT was successful at gathering feedback to develop training materials for pharmacies to deliver the TIMELY intervention. Participants were generally well-engaged in evaluating the prototypes and conducting the activities, although the pharmacy technician chose to work with their pharmacist rather than complete the exercise independently. The small number of participants and because most of the participants came from one company, this may mean there are potential issues or considerations relevant to other settings which have not been captured. This means that the findings here are unlikely to be transferable to other pharmacy settings. This may be especially true of pharmacies part of national or large multiples where resources and support are controlled and provided centrally.

The feedback has provided some useful insights on an initial attempt at designing a pharmacy training programme for delivery of the TIMELY intervention which should be subject to further evaluation prior to finalisation. Some of the suggested changes, such as a move to a fully online training package, also reflect the trajectory of pharmacy training in recent years. Concerns about pharmacy funding and capacity to deliver any new intervention have been echoed elsewhere in the sector and in previous research. As telehealth has also not been widely adopted in this setting, it would be expected that most pharmacy staff would have similar low levels of knowledge about telehealth systems to those included in this study. Two of the participants had attended focus groups as part of the co-design of the intervention concept study however, so had some prior knowledge about the TIMELY intervention although no experience of using the Simple Telehealth software.

Similar to other studies in this research programme, some of the feedback gathered may have been limited by asking participants for feedback when my own role in designing the interventions is clear. In this study, this could have been further exacerbated by using my

own professional networks to recruit participants. Community pharmacy recruitment was very challenging, despite accommodating an evening session which had proved successful in the co-design of intervention concept study. This could be due to the summer timing when pharmacists may have been away on annual leave, or the location as a computer suite was needed to support the simulated training aspect.

The pharmacy technician who attended the focus group chose to work with their pharmacist rather than attempt interacting with the Simple Telehealth software directly. This could suggest a lack of confidence to engage with new activities or software. As this was just one technician it's impossible to know at this stage whether this would be replicated with other pharmacy support staff. Despite this, pharmacists still felt that involving support staff was important as part of intervention delivery, though future implementation should explore whether the pharmacy support staff themselves share this view.

In comparison to the co-design of the intervention concept study, the ranking exercise in this study did not seem to add to the qualitative data gathered in the focus groups. This could be due to the small number of participants leading to little conflict between participants. It could also be because of the dominance of a single company. The use of the ranking stickers was not actively supervised, and this, combined with the small number of suggestions, led to votes not being used by all participants. This resulted in some suggestions not attracting any votes, although this does suggest that these ideas weren't as important.

8.5.2 Reflections on the community pharmacy training tools

For the eLearning, participants felt that the training exercise to use the Simple Telehealth software would also be better delivered in an online environment. This could also include additional examples to work through as suggested by participants. The pharmacy readiness self-assessment tool included a page of 'tick boxes' for pharmacists to confirm that pharmacists had the necessary knowledge and competence to support patients with all of

the long-term conditions included in the TIMELY intervention. These had been included based on a version for the NMS which was used as a template. The presence of the tick boxes prompted one participant to ask if additional learning needed to be completed in preparation for delivering the intervention.

The TIMELY intervention builds on the core expertise of community pharmacists, and as discussed in the introduction (see Section 2.3), community pharmacists in the UK NHS have been asked to deliver services for a range of long-term conditions. However, there does not seem to be much research evaluating whether pharmacists felt they had the necessary knowledge and skills following service implementation. The TIMELY intervention introduces new long-term conditions which had not been officially targeted for the delivery of pharmacy services at the point of data collection, in particular heart failure, chronic pain and depression. Whilst there are examples amongst the literature of community pharmacies delivering services for these conditions, it is important to establish if pharmacists feel prepared for supporting patients with these conditions.

As discussed in Chapter 7, the enablement consultation which replaces the MUR is important to support both medication-taking and patient engagement with text messaging. This means that there is a new training need for intervention roll-out in community pharmacies to reflect this. The Medicines-Related Consultation Framework (MRCF)[39] offers a structure which could be used in a future eLearning programme to guide pharmacists on conducting the enablement consultation in the absence of the MUR framework. The framework draws heavily from the work by Robert Horne's perceptions and practicalities model[38] and closely aligned with the programme theory for the TIMELY intervention to support through increasing motivation and capability for taking medication.

The COM-B model was helpful to design the initial training package for pharmacy teams. However, implementation of pharmacy services has not been evaluated using behavioural

frameworks previously. Therefore, the assessment of the barriers to performing the required behaviours (as described in Section 8.1.1) to support intervention delivery is predominantly based on my previous professional experience as a community pharmacist combined with the interpretation of findings from the peer reviewed literature. An alternative strategy to identify COM-B barriers could have been to use a standardised questionnaire, such as that provided by Michie et al.[157](pp. 68-69) to be administered following a detailed explanation of the TIMELY intervention. This could have then informed the design of the implementation tools. However, I felt there was sufficient experience of the tools that were likely to be helpful based on existing pharmacy services (such as NMS), use of the Simple Telehealth system in other settings, and the TIMELY steering committee team, to create the prototypes for this study as suggestions and get feedback on these. A COM-B questionnaire to explore the effectiveness of these tools could be useful to evaluate future training to implement the TIMELY intervention and check if they have supported the identified delivery behaviours.

8.5.3 Implementation considerations for the TIMELY intervention

This study also highlighted other implementation considerations for the TIMELY intervention. One issue raised was the capacity of community pharmacy to deliver the intervention. This was highlighted due to the time required by participants to set up the simulated patient on the Simple Telehealth software, and also by participants in the focus group data. Despite widening the intervention to involve support staff following feedback from the co-design of intervention concept study, whether community pharmacy would have the time and workforce to deliver the TIMELY intervention remained a concern.

Participants took around 30 minutes to select and amend the text messaging to set up the simulated patient. In comparison, completing this activity for the live simulation with patients took me between 1 minute and 12 minutes. Participants also had difficulty selecting the right protocols, and part of this seemed to be due to the naming conventions being very similar

(e.g. Necessity and Necessity-Concerns). Changing the naming convention would therefore identify the different types of protocols more easily.

An alternative may be to remove this work from the community pharmacy. Whilst the enablement consultation needs to be delivered locally, the set-up of patients' text message protocols in the Simple Telehealth software could be done remotely if the necessary information is transferred. Patients would be 'referred' to someone benefiting from experience of using the software and gaining the efficiency that comes with task repetition. This individual could service multiple pharmacies for a form of 'hub and spoke' delivery. This could be facilitated by software such as PharmOutcomes which already has this functionality and has been used to facilitate referrals from hospitals to community pharmacies on discharge. Another option could be to automate the setup of text message protocols, although this would require additional technical development work.

Another consideration for future implementation is the issue of clinical responsibility for the text message content. In the co-design of intervention concept study, pharmacists highlighted that it was important that they were comfortable with the content of the text message library if they were taking clinical responsibility for the text message content. At this stage, the text message library has not been evaluated in detail by community pharmacists and therefore this would be an area for further investigation.

Chapter 9 Co-design of intervention communication with general practice

The co-design of TIMELY intervention communication with general practice is described in this chapter and is the final study in this research programme. The aim was to develop and present a communication strategy for how community pharmacies would communicate about delivery of the TIMELY intervention to colleagues also providing care to patients in general practice. Once again, the Human Centred Design (HCD) framework (as introduced in Chapter 4) and a focus group with a modified Nominal Group Technique (NGT) was used to gather feedback on whether the designed communication would meet the information needs of general practice staff. This study was therefore an important element in considering the implementation of TIMELY as part of the complex intervention development process[144].

This study built on the findings from the co-design of intervention concept study (Chapter 6). This focus group study took place chronologically before the patient live prototyping study described in Chapter 7 and shortly after the co-design of pharmacy training study (Chapter 8). The study is presented here so that readers have a good understanding of the TIMELY intervention from Chapter 7 and the findings from the pharmacy training study also had a direct impact on data collection in this study, discussed later in this chapter. This means that the310tility310ee used in the present study to communicate the flow of text messages in the TIMELY intervention used an example from the Simple Telehealth community with some minor adaptations rather than one of those developed for Alice specifically.

9.1 Developing the communication tools for general practice

Within the UK National Health Service (NHS), general practice acts as the core healthcare delivery provider for patients. Whilst the concept of the TIMELY intervention had initial acceptability in general practice (as established in the co-design of intervention concept

study in Chapter 6), the details of what information was required by general practice and how it was communicated required further exploration.

In the NHS, all healthcare professionals are expected to record and maintain health records relating to their own delivery of patient care and this is set out in professional standards, such as those published by the General Medical Council[326]. The 'master' record which contains all information relating to an NHS patients' care is held in general practice. All providers who deliver care to a patient therefore notify their general practice for addition to their patient record[327]. In 2018, the Professional Record Standards Body (PRSB) developed standards for this communication in collaboration with the Royal Pharmaceutical Society and the Royal College of General Practitioners[328]. This was updated in 2021, however it does not currently cover any form of digital health interventions.

Multiple research studies have cited the importance of good communication with general practice as part of community pharmacy delivered care to improve integration and collaboration between the two healthcare providers[329–331]. Thus, designing effective communication tools for general practice to accompany the TIMELY intervention was an important objective as part of this research programme.

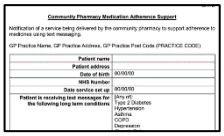
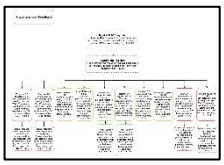
9.2 Prototype development for communication with general practice

To explore the potential information exchange between community pharmacy and general practice for the TIMELY intervention, three prototypes were developed (see Table 32). Each of these simulated how information would be provided to general practice. Each prototype was also linked to a design question as part of the TIMELY experience map (see Section 4.5.2).

9.2.1 Notification email

As part of the co-design of the intervention concept study, use of the software system PharmOutcomes was agreed by community pharmacists as a useful tool to facilitate information exchange between community pharmacies and general practices (see Section6.3.6). This software system supports the delivery of a notification email which can be sent automatically to a GP practice nhs.net email address on completion of a record by a community pharmacist. These notifications are customisable by those setting up service records within the software.

Table 32 Co-design of intervention communication with general practice experience map questions and prototypes

Design question from experience map	Prototype to be used	Click to view prototype	Scan to view prototype
What information on a notification letter will support appropriate information being added to the patient records for TIMELY patients?	Notification Email		
What information needs to be available on a web-based resource for general practices supporting patients receiving messages from the TIMELY intervention?	Mock-up website		
	Text message protocol summary diagram		

To explore the acceptability of such a notification email to general practice, a prototype notification email was created based on an existing example for influenza vaccinations obtained from Pinnacle Healthcare who managed the PharmOutcomes software[332]. A copy of this prototype can be found in Table 32. The version for the TIMELY intervention

consisted of the community pharmacy details, patient identifiers, date of text messaging set-up, long-term condition(s) for which the patient is receiving the intervention, if the patient is self-monitoring and a potential SNOMED CT code[333] was identified for addition to the patient record. There was also a free text comment box available, and the notification indicated a link to a website where more information could be accessed.

9.2.2 Mock-up website

A website about the TIMELY intervention was accepted as a potential strategy to communicate more information to general practice as part of the co-design of intervention concept study (see Section 0). To ensure that such a website would be easily navigable, a mock-up version was created using Google Sites[334]. The mock-up website was populated with navigation headings and some text, although not all anticipated text was added due to time constraints. The aim was to ensure that general practice staff accessing the website could easily navigate to the information that they required. A link to the prototype website is available in Table 32.

9.2.3 Text message protocol summary diagram

As demonstrated in Chapter 7, a text message protocol summary diagram is commonly used in the Simple Telehealth community to describe the content of text message protocols. The two-way automated nature of the Simple Telehealth system means that it is often necessary to describe the relationships between text messages as well as the messages themselves. This includes the order in which messages are sent, and how replies are triggered based on responses from patients. Within the Simple Telehealth community, these text message protocols are often communicated using colour coded flow diagrams. To test the313tilityy of these flow diagrams to general practice staff, an example was used as a prototype (see Table 32). The flow diagram was an example of a text message protocol for hypertension from the Simple Telehealth community which was in draft form for the TIMELY intervention at the time of data collection for this study.

9.3 Focus group with modified nominal group technique method to gather feedback on communication tools for general practice relating to the TIMELY intervention

To gather feedback on the communication prototypes, a focus group with modified NGT was used. This provided the opportunity to collect qualitative data and prioritise changes or aspects of the communication that were important for re-iterating the design as per guidance on developing complex interventions[144]. As several types of health professional provide care to patients in the general practice setting the aim was to include all perspectives, including: nurses, pharmacists, and general practitioners.

The focus group was held at one general practice to replace their usual practice meeting. The prototypes were presented in order from least to most detail about the intervention, reflecting the order that general practice staff would likely access the information. This started by evaluating the notification email, followed by the TIMELY mock-up website, and finishing with the example text message protocol summary diagram. Due to time constraints within the project, just one focus group was planned.

9.3.1 Participants

The aim was to include any healthcare professional in general practice who may receive or need to seek information about the TIMELY intervention. This included GPs, practice nurses and practice pharmacists.

9.3.1.1 Inclusion criteria

- 18 years of age or older
- Currently practising as a healthcare professional in a patient-facing role within the general practice including: GPs, practice nurses, practice pharmacists.
- Are able to understand, read, write and speak English

- They are willing to participate

There were no additional exclusion criteria.

9.3.1.2 Sampling

A convenience sample was used consisting of healthcare professional participants associated with a single general practice which agreed to participate in the study. The target sample size was 5-10 participants in the one focus group which was planned. This would represent around half of the healthcare professionals (total 14) currently at the practice.

9.3.1.3 Participant recruitment

The general practice was recruited using my own professional network. Healthcare professionals working in the general practice site were emailed an invitation letter, participant information sheet and consent form prior to the focus group (available in Appendix 33, Appendix 34 and Appendix 35). Potential participants were provided with my contact details for questions in advance of the focus group and informed the study would replace their usual meeting. Consent forms were collected at the start of the meeting and consent was also confirmed following a verbal introduction before audio recording began.

9.3.2 Focus Group with modified NGT

The format for the focus group with modified NGT[288] was similar to that for the co-design of intervention concept study, with participants asked to identify characteristics that they liked and aspects that needed to be changed for each prototype presented. The ranking exercise happened at the end of the focus group similar to the pharmacy training study.

9.3.2.1 Data collection

Aspects participants liked and suggestions for changes were captured initially on coloured post-it notes and added to flip charts. NH themed the post-it note suggestions and added these to the flip-chart in preparation for the ranking exercise. Once all prototypes had been presented, the post-it notes generated and themed together on flip charts, participants were provided with numbered stickers to rank the three items they felt were most important for change, and to keep. The focus group was also facilitated by use of a topic guide (see Appendix 36). Audio recordings were made of the focus group discussion and were transcribed verbatim to facilitate analysis. No further data sources were used in this study.

9.3.2.2 Data analysis

Data from the focus group discussion transcript, completed post-it notes and from the voting exercise were triangulated as part of the data analysis. The transcript was initially coded using Framework approach[290] similar to the methods used in previous studies in this research programme. Deductively derived codes were used first to identify feedback about the specific prototype and whether data represented an aspect participants liked or wanted to change. This was followed by inductive coding to identify specific suggestions. Each of the changes and aspects which participants liked were scored by converting rank numbers allocated in the focus group to a numerical value and adding these to create a total score for each suggestion. In this study the participants added items to post-it notes which were unrelated to the prototypes themselves. These were included in the prioritisation exercise on the day, depending on what prototype was being discussed at that moment. However, this resulted in items which did not support a change or aspect relating to the prototype, but a different element of feedback relating to the intervention. These items are described in the results section (see 9.4.4) but are discussed separately to the prototypes themselves.

9.3.3 Ethics and governance approvals

This study was approved by University of Sunderland Research Ethics Committee (Reference number 004613) and received Research Governance approval from the NHS Health Research Authority (Reference 19/HRA/4119) at the same time as those for the co-design of intervention delivery with community pharmacy study. No incentives were provided.

9.4 Results from co-design of intervention communication with general practice

The focus group took place on 31st July 2019. There was a total of seven participants who attended the general practice focus group, including six general practitioners and one practice nurse. The focus group lasted 46 minutes. The first section of the results is organised around feedback for each of the prototypes with a summary of the qualitative analysis alongside scores from the NGT ranking exercise. However, comments which were unrelated to the prototypes are contained in a separate section which represents feedback themes which relate to comments on the TIMELY intervention itself.

9.4.1 Notification email

A summary of the NGT scores for aspects that participants would like to change about the notification email can be found in Table 33. The general practice staff had some debate within the focus group about the purpose of the notification email, and how it would be processed within the practice when it was received. There was concern about how frequently these notifications would be sent by pharmacies, and that if they were received more frequently that this would reduce the likelihood that GPs would read them.

> *"I was thinking essentially we get things like this from out of hours and you get a hundred things that look the same. So if I get a hundred of these through, I'm not going to read a single one of them. So I'd only want ones with useful information on."*
>
> *General Practitioner Participant*

Table 33 Results of the NGT ranking exercise for aspects that participants would like to change for the GP notification prototype

Aspect for change	Nominal Group Technique Score
Multiple versions/ notifications not required	No votes
More information needed about the intervention	4
The term 'adherence' should be used instead of 'compliance'	19
Add whether action is needed on receiving the notification	No votes

However, when it came to the nominal group ranking, as shown in Table 33 there were no votes for the suggested change of multiple versions/ notifications not required. Similarly, there was also debate about what information might be contained within the comments section of the notification, and that if action was required by the GPs that this needed to be presented clearly.

"Well, I guess if there's a useful thing that the pharmacist was saying, if that was in bright red, or in bold."

General Practitioner Participant

In the ranking exercise this did not receive any votes. The lack of votes may have been due to a counter argument that was presented by another GP, that there is a requirement for GPs to receive such information, and that it should be processed in line with other documentation received by practices from other healthcare providers.

"I was going to say, if it comes by I don't mind. The girls can scan the normal ones and just put those ones through our process."

General Practitioner Participant

This may have resonated with the rest of the group, and both these former comments came from the same participant, suggesting that their views were a minority.

The SNOMED code added to the notification letter was also a source of debate as it used the word "compliance". The practice nurse participant highlighted that this word to describe

medication adherence had fallen out of favour and suggested that this needed to be changed to adherence. This suggested change had the highest score in the NGT voting exercise.

Aspects that participants liked about the GP notification email included that the format of the notification was clear and easy to read (see Table 34). Post-it note comments also suggested that participants liked the information being contained on one page and all the information required was given, but these latter comments did not attract any votes. This may suggest that participants might be happy for the notification to be longer to accommodate the additional information they felt was needed.

Table 34 Results of the NGT ranking exercise for aspects that participants liked about the GP notification email prototype

Aspect liked	Nominal Group Technique Score
Format is clear	3
Easy to read	9
Contained on one page	No votes
Contains all information required	No votes

9.4.2 Mock-up website

The discussion about the mock-up website highlighted some differences of opinion about what level of information general practice staff wanted about the TIMELY intervention. There were questions about whether practice staff could access the messages sent and the replies from patients, rather than seeing an overview of the intervention on the TIMELY website.

> *"I'd like to be taken through as if I was the patient receiving the messages. I'd like to see what the message was and then what happens after that. And then do we get relayed with their reply, or does that go to the pharmacist? What happens?"*
>
> *Practice Nurse Participant*

This comment was made by the practice nurse. One of the GPs expressed that they didn't agree with this. However, this comment wasn't transposed onto a post-it note for

consideration in the ranking exercise. One participant submitted a post-it note for a change which said that they may not access the website very often, although it did not ultimately get any votes (see Table 35). Another change suggested on one post-it note but not attracting any votes was that the graphics on the website should be 'clickable' as part of website navigation. The only change attracting any votes was that the flow diagrams should have better resolution as the one used in the prototype was blurred.

Table 35 Results of the NGT ranking exercise for aspects that participants would like to change about the TIMELY website prototype

Aspect for change	Nominal Group Technique Score
May not access the website very often	No votes
Header graphics should be clickable	No votes
Flow diagram needs to be a better resolution (version available was blurred)	6

On the post-it note feedback, participants said that the website was clear and easy to navigate and liked that it was accessible on a mobile phone (see Table 36) but these comments didn't attract any votes. There was a score of 4 however for being able to access information when required using the website.

Table 36 Results of the NGT ranking exercise for aspects that participants liked about the TIMELY website prototype

Aspect liked	Nominal Group Technique Score
Clear and easy to navigate	No votes
Able to access information when required if available on a website	4
Accessible on a mobile phone	No votes

9.4.3 Text message protocol flow diagram

There was only one theme of comments for the flow diagram itself which was that it was clear, and this attracted a NGT Score of 3. The rest of the discussion was about the content of the protocol itself. There were no suggested changes for the format of how the information was presented, and indeed the discussion around the text message protocol indicated that

participants had correctly interpreted the flow diagram and were therefore confident enough about how the text messages worked that they felt able to critique the protocol itself, although their comments on the protocol content will be discussed separately.

9.4.4 Views on the TIMELY intervention

The GP practice used for data collection in this study was the same as that used for the co-design of intervention concept study. There was a large overlap in participants between the two data collection points. As the focus in this study was on how the intervention would be communicated to practices, and because the time available with the practice was limited to 60 minutes, there was not a lot of information provided at the start of the focus group on the TIMELY intervention itself. NGT ranking and comments which may appear missing from the previous sections of results was due to a dominance in the discussion of the TIMELY intervention itself. Themes from this discussion have therefore been presented in two additional results tables on this topic.

Table 37 presents post-it note comments and NGT scores for aspects of the intervention that participants liked, based on the discussion of the text message protocol summary diagram. Participants liked that the intervention offers reassurance for patients and that the advice provided was positive.

Table 37 Focus group themes and NGT scores from general practice participants relating to the TIMELY intervention and aspects liked

Aspect liked	Nominal Group Technique Score
Intervention offers reassurance for patients	4
Advice provided is positive	2

In Table 38, there are the suggestions from participants for what aspects of the intervention they felt needed to change or that they were unsure about. The highest scoring change was that the intervention could increase GP workload.

Table 38 Focus group themes and NGT scores from general practice participants relating to the TIMELY intervention and aspects for change

Aspect for change	Nominal Group Technique Score
Not sure that the intervention is needed	9
Not sure that community pharmacy has the capacity to deliver the intervention	6
Where BP is out-of-range patient should be directed to call GP rather than pharmacist	6
Intervention could increase GP workload	15

Within the qualitative data there seemed to be two major reasons that participants felt that the intervention would increase GP workload. The first was that when verbally describing the intervention, messages about potential side effects in the 'reduce medication related concerns' message category were used as an example. This prompted discussion which conveyed a feeling that telling patients about side effects from their medication would cause patients to think that they had these side effects and would book appointments with their GP to discuss these.

"Everyone would come in and imagine they've got the side effects"
General Practitioner Participant

The second perceived source of increased GP workload was an extensive discussion about the professional autonomy of community pharmacists. A series of questions were asked by participants about what the pharmacists would do, for example if the patient rang them to discuss an abnormal blood pressure reading. Responses to these questions from participants were vague, that it would depend on an assessment of the patient by the pharmacist. However, it was made clear that changes to any prescription medication would require authorisation by the GP, as the community pharmacists would not be prescribers.

"Because if the pharmacist isn't going to do anything, then why bother ringing the pharmacist? Why not just directly ring the GP? But if you are going to intervene and do something, and then that reduces the workload for the GP."
General Practitioner Participant

These comments were linked to the suggested change that if the BP was detected out of range, the patient should be directed to call the GP rather than contact the pharmacist (see Table 38). Participants seemed to be sceptical of the value of the pharmacist receiving queries from patients and felt that these would likely result in GPs needing to act, thereby increasing their workload. However, it was unclear if these comments related specifically to their experience of community pharmacists. Most of the comparisons throughout the discussion were comparisons to NHS 111, although some of these comments may have been prompted by the reference to NHS 111 in the hypertension flow diagram.

"No, but it's just [mimics patient] "Oh doctor, I rang 111 and they've said I've got to see a doctor within two hours." So it's a panic because it's an emergency."
General Practitioner Participant

There was also much debate about the capacity of community pharmacy to deliver the intervention. This focus group took place after that with community pharmacy staff involving the simulated training exercise. One participant asked how long it would take community pharmacies to deliver the intervention, and information from the training exercise was provided. Whilst this was caveated by saying this was first time use of the software, and there could be other models of delivery, this did not seem to make much difference. One participant in particular was sceptical that community pharmacy was likely to be able to deliver the intervention.

"… have they got time, or are they too busy dispensing meds?"
Practice Nurse Participant

The last piece of feedback which attracted comments and votes was that participants were unsure of the value of the intervention. This was partly linked to earlier discussions about the provision of side effect information. Feedback on whether the intervention was needed seemed to be linked to a perception that GPs and pharmacists were already counselling patients on their medications, so were unsure what the TIMELY intervention was adding.

"We seem to be spoon-feeding people all the time. We give them instructions on how to use the medication, why they're using it, why is it important, pharmacists do. Then you go through all this again and it's more…"

General Practitioner Participant

This argument was countered by others in the group.

"We assume everybody takes stuff as we prescribe it when they leave a room, but we know that that's not necessarily the case."

General Practitioner Participant

There were also comments about how older people use technology, and whether a text messaging intervention was appropriate for this group.

"Because obviously a lot of patients, especially older patients are just no good with things like that. They don't use them, or it relies on them having their phone all the time. I know even when I'm at home my phone gets put down."

General Practitioner Participant

Whilst it was not the intention of this focus group to collect feedback on the intervention itself, the discussion does provide insight into potential changes that need to be made to support communication with general practices as part of the TIMELY intervention.

9.5 Discussion of findings from the co-design of intervention communication with general practice

This study aimed to gather feedback on how best to communicate with general practice about the delivery of the TIMELY intervention. Whilst much of the discussion in the focus group was a divergence from gathering this feedback, the findings have provided insight into each of the prototypes which were presented. The data also included some unanticipated information needs which may be important to incorporate as part of future delivery of the intervention.

9.5.1 Strengths and limitations of the focus group with modified NGT to gather feedback from general practice on the TIMELY communication tools

This study was limited by representing the views of only one GP practice. The practice used in this study represents a large population in Sunderland and is very close to a community pharmacy with whom they have a relatively good working relationship. The national contracting for general practice and community pharmacies in the NHS means that some views expressed in this small study may be shared by others, however, it is not possible to know to what extent. Therefore, re-examining communication tools with general practice will be important. The voting element of data in this study was also limited by participants providing feedback unrelated to the prototypes and not using their votes as instructed.

Gathering feedback on communication tools with general practice relating to the delivery of pharmacy services has been little studied. Conducting the focus group as a replacement for a practice meeting also meant that an element of bias from personal self-selection was limited and there was also a lot of robust discussion and feedback from the group. The data collection and analysis from this study has successfully provided insight to support the re-iteration of communication tools for future implementation of the TIMELY intervention.

9.5.2 Reflections on the communication tools for general practice about the TIMELY intervention

The communication tools presented as prototypes in this focus group received generally positive feedback, suggesting that these are an acceptable communication strategy for the TIMELY intervention. Minor suggested changes around wording and diagram resolution can be easily incorporated into the final communication tools. However, comments reflecting the lack of perceived need for the intervention highlight that it cannot be assumed that GPs recognise the scale of medication nonadherence. There is evidence that healthcare professionals frequently seem to over-estimate their patients' medication adherence[335–337]. More recently, a qualitative study in Finland found that GPs did acknowledge that around

half of their patients had problems with medication adherence[338]. The findings from this study also found that GPs suspected that patients hid their nonadherence, and this was thought to be due to their position of authority.

The findings from the focus group also suggest that there is an underlying assumption that because GPs counsel the patients on their medication and this is potentially repeated by the community pharmacist, that this is enough to ensure adherence. Research has revealed that there are often discrepancies in perception about the causes of medication nonadherence between patients and doctors[335,337] as well as what are perceived to be the most helpful solutions. However, what is interesting in this data is that the GPs did acknowledge the role of pharmacists in counselling patients on their medicines. This is in contrast to other work, particularly with the New Medicines Service (NMS) where GPs have been less inclined to acknowledge this role[83]. This could have been due to a good relationship with the practice's local community pharmacy in this case. In future iterations, information about the effectiveness of the TIMELY intervention may also be helpful to include in GP communications once this has been investigated.

The participants in the focus group also suggested that any comments on the GP notification email should only appear where action was required on their part. Guidance could be provided to pharmacies as part of the implementation of the TIMELY intervention about what to include in this section of the notification. Use of the comments section on the notification email could also be evaluated as part of a future evaluation study of the intervention.

This study also found discrepancies in the level of detail that participants wanted about the TIMELY intervention. It is currently anticipated that in future implementation, general practice staff would be able to access the patients' text messages in the Simple Telehealth software. However, with the self-monitoring data from TIMELY being predominantly for use by the pharmacists, it is unclear to what extent practices would access this information and how it

would be used. Providing information about the availability of access may be a good addition to the GP notification email.

The detailed discussion of the hypertension flow diagram example demonstrated that the presentation of text messages was clear. All comments did reflect the actual functioning of the text message protocols. Therefore, this continues to be a good mechanism to present how two-way text messages with Alice function to those without in-depth knowledge of how the Simple Telehealth system works.

9.5.3 Implementing the TIMELY intervention from a general practice perspective

Whilst the intention of the focus group was not to examine the implementation of the TIMELY intervention, feedback from participants revealed further implementation questions to explore from the perspective of general practice. This study suggests the use of predominantly digital communication. This has been found to be acceptable in a qualitative study in Australia for minor or routine interactions[330]. However, this and other research has found preferences for face-to-face communication for developing a more collaborative relationship[330,331]. Therefore, how community pharmacies collaborate with general practice to address medication adherence issues and how this is achieved, is something for exploration for the TIMELY intervention in future studies.

Another issue raised was the role of NHS 111 in the TIMELY intervention. Participants suggested safety netting using NHS 111 was not a good strategy based on the service's conservative approach. This concern may have been prompted by survey results published in *Pulse* magazine released just before the focus group, claiming a large number of inappropriate referrals into general practices per month[339]. However, there will continue to be a gap for patients seeking help when normal healthcare services are closed. Future research should seek to explore how many patients seek help from NHS 111 because of a text message from Alice, and the outcomes of these consultations.

General practice staff also expressed concerns about the value of contacting the pharmacist. Reluctance of GPs to refer patients to pharmacy services where there is uncertainty about how the service works or if it will be effective has been found in qualitative work by others[331]. This led to concerns that patients would ring the GP rather than the pharmacy and this would increase workload in general practice. However, evidence from the NMS found that referrals to general practice from pharmacies for patients newly initiated on antihypertensive medicines were only 4.5%, despite relatively high prevalence of reported of side effects (19%)[340]. The study also found a range of patient related concerns that community pharmacists supported patients to resolve without further referral into general practice.

Concerns about GP workload relating to patient queries about side effects is not unfounded. A qualitative study in Germany found that patients were most likely to ask their GP about side effects[341] although a pharmacist was mentioned as an alternative. In the UK, services such as the NMS have raised the profile of pharmacists as a source of medicines information. However, until the TIMELY intervention is tested at scale it will not be possible to tell what messages from Alice trigger contact with the pharmacist, what actions the pharmacist takes, and whether this does have an impact on GP workload.

Chapter 10 Discussion

This general discussion chapter will reflect on my work to answer the research question: can an intervention be designed which combines automated two-way text messaging and community pharmacy support to improve medication-taking, in patients with multiple long-term conditions? This chapter is organised around the three contributions this work makes to the current body of knowledge. These relate to the methodological process of developing the TIMELY intervention, the automated two-way text messaging programme which was created (also known as Alice), and the design of a delivery model from a community pharmacy setting. Within each of these aspects, key findings from the research will be highlighted and comparisons made to the literature. Implications for practice across all three aspects will be provided in the second half of the chapter, alongside the place of the TIMELY intervention in the NHS. This is followed by some reflections on how the recent Covid-19 pandemic has affected this research and re-contextualised the intervention for future implementation. The chapter finishes with recommendations for future research. A conclusion chapter follows.

10.1 Summary of main findings for the development of the TIMELY intervention

The TIMELY intervention was developed in three stages. Aim 1 aimed to identify the factors which create successful automated two-way digital communication interventions to support medication-taking. Aim 2 involved co-designing the concept for the new digital communication intervention to be delivered from a community pharmacy setting. Aim 3 sought to consider how the intervention should be delivered. Each stage provided greater intelligence about what content should be included in text messages to support medication-taking, and how such an intervention should be delivered within a community pharmacy environment.

The narrative synthesis systematic review laid the foundation for the intervention development process, by identifying and evaluating the content and delivery of 37 interventions using automated two-way digital communication to support medication adherence (see Chapter 5). The analysis of those studies identified a range of behavioural targets and Behaviour Change Techniques (BCTs) which could be used for automated two-way digital communication and 'live' interactions, usually with healthcare professionals.

Findings from the narrative synthesis systematic review and from the Behaviour Change Wheel (BCW) guide[157] were then used in the development process to design the concept for the new intervention. The concept was communicated in a series of prototypes as part of a Human Centred Design (HCD) process (see Section 6.1). The concept was then explored with patients and primary care healthcare professionals using the prototypes in focus groups and using a modified Nominal Group Technique (NGT) (see Section 6.2). This process confirmed that the initial intervention concept was acceptable to patients, community pharmacists, practice nurses and general practitioners. It also captured and prioritised changes related to aspects of intervention content and delivery (see Section 6.3). This process was replicated for testing prototypes for communication between community pharmacies and general practice (see Chapter 9).

The research programme also used 'live' prototypes of intervention delivery. This included a simulated community pharmacy training event (see Chapter 8) and intervention delivery with patients (Chapter 7). These simulations facilitated the collection of qualitative data from participants, software logs of interactions in Simple Telehealth, and data from the completion of the intervention personalisation questionnaire. Completion of the personalisation questionnaire by patients provided additional contextual data for each participant. Completion of the 'pharmacy use only' page in the simulated pharmacist training enabled better understanding of how well the training supported behaviours required for intervention

delivery. These data allowed triangulation in the analyses to understand how TIMELY could be better optimised for future delivery.

The development of the text message library (see Section 7.1) was a substantial piece of work as part of intervention development. Although the simulation only lasted for two weeks, a text message library for a 12-week intervention was created. This content was grounded in the findings of the narrative synthesis systematic review and other high-quality sources, such as additional peer-reviewed literature, content from the Simple Telehealth community and patient information from national charities. Having the full database of messages available also meant that text message content could be discussed in the semi-structured interviews beyond those messages received during the short simulation.

The live simulation of intervention delivery with patients served several purposes, it provided an opportunity to assess patient acceptability of intervention content and delivery and to gather data on how the intervention may work to support medication-taking. Data from this study also shed light on how intervention delivery components supported patient engagement with the automated two-way text messaging with Alice, the intervention persona. Others have suggested that using real examples of text messages makes it easier to gather feedback from participants and that accurate acceptability of an intervention cannot be assessed until it has been used in a real-world setting[342].

10.2 Comparisons to the literature on similar intervention development

Descriptions of intervention development from studies included in the narrative synthesis were lacking. Some studies described gathering feedback from patients, usually using focus groups[229,232,233], with most others describing the development taking place by the authorship team. Guidance on developing digital healthcare interventions has been published by Abroms et al.[141] and has been used for recent interventions[342,343]. The framework by Abroms et al. includes many of the features present in the process described in my research. They

suggest using a behavioural approach, making use of logic models, designing a framework for delivery, writing the message library and pre-testing the text messaging programme.

The overall strategy for developing the TIMELY intervention did not initially draw from any published frameworks. The guidance in the Medical Research Council (MRC) framework at the point of designing this research programme (the 2008 version[138]) was much less specific than the subsequent 2019 version[144]. So the process for intervention development was shaped from accessing the University College London Behaviour Change Summer School, and subsequently the HCD training programme using the IDEO.org framework[163]. The updated version of the MRC framework published in 2019[144] however, aligned with the approach that was taken and made many suggestions which were included in my own development process.

Three other interventions similar to TIMELY have been developed more recently and also provide comparisons to the approach taken in this research (see Table 39). Authors developing the S-Map[156] and MAPS[344,345] interventions used predominantly qualitative methods for gaining feedback similar to the approach used here. However, the SuMMiT-D research used a message development workshop with healthcare professionals and behavioural experts, a focus group study with patients, and message acceptability and then fidelity survey[342]. The text message writing workshop for SuMMiT-D used BCTs from a rapid review as a starting point. Expert participants were then invited to write text messages using the identified BCTs for their intervention, followed by a filtering process to only include BCTs which were ‘plausible’ for delivery. How this decision was made is not described.

Table 39 Summary of recent interventions similar to TIMELY developed in the UK

Research Programme	Population	Intervention description	Intervention setting	Development process
Support through Mobile Messaging and dIgital health Technology for Diabetes (SuMMiT-D)[277]	Patients with Type 2 diabetes (not on insulin)	One way text messaging	General practice	1st. Review of reviews to identify barriers to medication adherence in T2DM and behavioural strategies to improve adherence[278] 2nd. Message writing workshop based on identified BCTs with healthcare professionals and health psychologists[342] 3rd. BCT and text message testing with patients using focus groups [318] 4th. Testing of text message library with patients for acceptability and usefulness using an online survey[342] 5th. Testing of text message and BCT library for acceptability with clinicians and BCT fidelity with health psychologists using an online survey [342] 6th. Pilot and feasibility study of the intervention[346] (pending results publication) 7th. Full Randomised Controlled Trial (completed results pending)
Solutions for Medication Adherence Problems (S-Map study)	Older patients with polypharmacy	Tailored medication support	Community pharmacy	1st. Systematic review of theory-based interventions to improve medication adherence in older adults with polypharmacy[51] 2nd. Focus groups with older patients with polypharmacy to identify potential intervention components[156] 3rd. Identification of BCTs and delivery format for a future intervention[347] 4th. Feasibility study of the intervention[347]
Medication Adherence for Patient's Support (MAPS) [348]	Patient with hypertension and/or Type 2 diabetes	Tailored text messaging and Interactive Voice Response phone calls	General practice	1st. Systematic review, meta-analysis and meta-regression of RCTs to identify BCTs included in SMS/IVR Interventions[194] 2nd. Qualitative study with patients to identify reasons for medication nonadherence in hypertension/ T2DM[344] 3rd. 'Experiential' focus groups with PCPI participants[345] 4th. Prototype building and testing with PCPI participants[345] 5th. Pilot of the intervention in general practice[345] 6th. Feasibility randomised controlled trial[349]
BCT: Behaviour Change Technique; PCPI: Patient, Carer, and Public Involvement; T2DM: Type 2 Diabetes Mellitus				

To evaluate text message content from the patient perspective, the SuMMiT-D intervention used an online survey to assess understanding, whether patients liked the messages and how useful messages were. For MAPS, text messages were sent to patients in a focus group, followed by working with PCPI participants and using a small pilot. Ensuring that content evaluation by patients is completed by the target audience for those messages is important due to the social desirability bias associated with medication adherence. Research participation in studies such as TIMELY seems to be with patients whose medication-taking is already good. This results in participants talking about other peoples' experiences rather than their own, which was evident in my research as well as other studies[318]. One explanation may be that the use of focus groups further heightens the need to fit into the 'socially desirable' category of someone who takes their medicines.

This potential bias may have the potential to interfere with medication adherence intervention development. In the focus group to develop the SuMMiT D intervention[318], participants felt that lifestyle changes were more challenging to them managing their diabetes than medication-taking. This seems to have re-focussed the intervention on these behaviours rather than those to support medication adherence. To counter this, in the development of TIMELY, I started from an assumption that everyone needs help with medication-taking, even if they could be considered 'adherent'. Whilst discussions in the co-design of intervention concept study did often revert to 'other people' who do not take their medication, this did not prevent me from gathering feedback on ideas for this intervention.

The use of one-to-one interviews as part of the patient delivery simulation study was also a strategy to limit the impact of the social desirability bias of medication adherence. The experience of receiving the tailored intervention allowed assessment of the utility of the TIMELY intervention based on individual circumstances. Although participants still speculated about how the intervention could be helpful for others, I was able to pursue

questions about whether the intervention had also been helpful for them personally, even if they did feel that they were a 'good' patient who took their medicines as directed.

An additional stage to developing digital communication interventions by Abroms et al.[141], which may be helpful in further development of the TIMELY intervention, could be to check the literacy demands of the text messages and consider the relative importance of messages to inform decisions about the inclusion of different types of content.

10.3 Strengths and limitations of intervention development

The strengths and limitations of each of the studies included in the research can be found in their corresponding chapters. The purpose of the following section is to consider the strengths and limitations of the overarching methodology to create the new TIMELY intervention.

10.3.1 Use of behavioural theory

The use of theory in intervention design and development is often deemed a quality indicator, and is suggested in the guidance by Abroms et al.[141]. Therefore, the use of the BCW in this research programme could be considered a strength. This research also builds on work by Jackson et al.[44] by dividing medication-taking into four inter-linked medication-taking behaviours. Whilst many of the factors which may influence each of these behaviours would be very similar to those outlined by Jackson et al.[44], separating these behaviours facilitated a better understanding about how to achieve improvements in medication-taking.

The BCW itself is a composite framework resulting from a synthesis of 19 behavioural frameworks[43], however, only the framework for Sexually Transmitted Diseases[350] specifically considered medication adherence. A range of other behavioural theories have been used to examine medication-taking, including those examined in the narrative synthesis systematic review. These included self-efficacy theory[235,236], social cognitive theory[234,245], self-regulation

theory[244], the theory of planned behaviour[249], the benefit-risk model[229], the health beliefs model [255], and the transtheoretical (stages of change) model[255]. Another systematic review found many of these same theories in use for interventions to improve medication-taking in older adults taking multiple medicines[51].

For me, however, the BCW represented a holistic treatment of the medication nonadherence problem, drawing on practical, social and motivational barriers to medication-taking, which are complementary to work on medication adherence by Robert Horne[34,35,37–39,283] and the Self-Regulatory Model[33]. The BCW has also been developed to be easily understandable to the non-specialist, and I was able to attend the Behaviour Change Summer School as part of my training programme to learn how to apply it to this research programme.

The BCW also provided a framework for evaluating behaviours associated with intervention engagement by patients (see Section 7.3.2.7) and delivery by pharmacists (see Section 8.1.1). Using a theoretical model such as the BCW can also help to fill evidence gaps where there may be less research examining the identified target behaviours, but more informal knowledge is available, such as my previous experience as a pharmacist.

Whilst the aim of theory is to be generalisable, the BCW may not explain all nuances around why people do or do not take medication. Rates of medication adherence are known to vary between medicines and long-term conditions[22]. Evidence that general concerns and perceived necessity are predictors of medication nonadherence does not illuminate specific concerns for specific medicines. Therefore, there could be a mismatch in the text message content with the concerns that patients hold about their medicines. This equally applies to what information may persuade patients of the benefits of medication-taking. Patients taking multiple medicines are also more likely to be nonadherent[28,29] and the extent to which theories apply in this context is unknown.

10.3.2 Use of realist programme theories

Behavioural theories were used in this research to create realist programme theories (see Section 4.3) similar to the logic models suggested in the guidance from Abroms et al.[141]. This research started with a first iteration for a programme theory for how the TIMELY intervention may work to support medication-taking (see Figure 7) which was then iteratively refined using evidence gathered from the narrative synthesis systematic review (see Figure 12) and ultimately the live simulation study with patients (see Figure 28). Each iteration added more specificity about behavioural mechanisms and some initial contexts which may be important mediators of intervention effectiveness. These programme theories will be an important foundation for future research using a realistic evaluation approach (see Section 10.9.2).

10.3.3 Use of prototyping and Human Centred Design

The recommendation to use prototypes in the MRC Guidance for Developing Complex Interventions[144] was based on a review[140] of both published and theoretical approaches to intervention development. No identified examples used HCD. Therefore, the use of IDEO.org's model for developing the TIMELY intervention offers a novel approach to complex healthcare intervention development.

There were few examples of using prototypes for the development of pharmacy interventions prior to this work. Sending information to participants before attending a feedback event has been used for gathering perceptions of community pharmacy services[351]. Hutchings et al.[293,352] used photos to prompt discussion about patient-centred professionalism in the community pharmacy setting. However, IDEO.org have recently produced a guide for using HCD in public services which includes an example of a simulated pharmacy[353].

In this research, using prototypes facilitated clear communication of intervention ideas, which supported participants to provide specific feedback. As the prototypes were designed based on findings from the systematic review and the BCW, the ideas presented were grounded in research evidence. Using prototypes was a strength of the approach used here and offers a way of combining research evidence and professional experience into new ideas for interventions or services for feedback from stakeholders.

10.3.4 Who is involved in the intervention development process

Involving a wide range of participants is a strength of this intervention development process. Other research has found misconceptions about what Technology Enabled Care Services (TECS)[320] are and there was limited data from clinicians identified in the narrative synthesis systematic review. Only the study by Cottrell et al.[270] using the Simple Telehealth system examined clinician perspectives on TECS directly.

For the SuMMiT-D intervention, General Practitioners (GPs) were included in the text message writing workshop[342], but the plans for implementation did not seem to be considered until later in the research programme. Patton et al. identified community pharmacy as the delivery setting and involved pharmacists from the beginning of the development process for the S-Map intervention[156]. A small pilot of the intervention in the MAPS study also included qualitative work with general practice healthcare professionals[345]. However, TIMELY included both general practices and pharmacy staff to consider the wider impact of intervention delivery. Other researchers have highlighted the importance of co-producing designs for community pharmacy services with wider stakeholders such as GPs[83,329].

Exploring the training needs of pharmacists to deliver the complex intervention is also a strength of this research. Cork et al.[135] had previously struggled to achieve ‘buy in’ to use Simple Telehealth text messaging protocols focussed on self-care behaviours in the

community pharmacy setting. Therefore, assessing potential 'buy in' from community pharmacy was an important question in the design process. In both the co-design of intervention concept study and the pharmacy simulated training study, pharmacists (and patients) seemed to see the alignment between the TIMELY intervention and their current pharmacy roles. This should increase coherence about implementing telehealth in this setting.

One group which has not been widely consulted during intervention development was behavioural experts. In the SuMMiT-D trial, fidelity of text message content for delivery of BCTs was assessed by behaviour change experts. Examples of text messages, and their BCTs were explored qualitatively in the co-design of intervention concept study with healthcare professionals. As these professionals (GP, Practice Nurses and Community Pharmacists) are unlikely to have had behaviour change knowledge, the assessment of BCT delivery is lacking in the TIMELY development process. It could be argued, however, that my training and use of the BCW as part of this research programme, ensured sufficient expertise and understanding to create text messages with good behavioural fidelity.

10.3.5 Intervention developer as researcher

In all studies, participants could have been reluctant to share feedback due to my dual role as intervention designer and researcher. Any impact may have been mitigated in the tone setting of data collection, where I always made explicit that all ideas and feedback were welcome. Participants were also provided space and time to think prior to participating in discussion, such as through the silent generation of ideas in focus groups, and participant diaries. Comparisons of these sources with transcripts during analysis did not reveal any ideas unaired during verbal discussions, although participants knew I would have access to these sources. Recruiting patient participants from the University of Sunderland PCPI group also meant these participants were more familiar with providing feedback to academics.

10.4 Alice

Alice is the automated two-way text messaging persona developed in this research to support medication-taking in combination with support from a community pharmacy. Text message content delivered by Alice is tailored based on an assessment of patients' potential medication needs, covers eight long-term conditions, and delivers specific BCTs selected to influence particular medication-taking behaviours. Each of these design elements will now be discussed, including how decisions for each of these was made during the development of Alice and a comparison to other similar interventions. This is followed by some recommendations for digital communication intervention design based on the experience of the TIMELY intervention and what unknowns remain for future investigation.

10.4.1 Two-way communication

Two-way communication had previously been highlighted by others to be important for medication adherence[111,116,118,123,218]. The narrative synthesis was able to identify some of the behavioural mechanisms which supported this, supplemented by findings from the co-design of intervention delivery with patients study (see Section 7.4.3). Further evidence which suggests superiority of two-way messaging interventions for medication adherence is the lack of effect found in a recent study by Bermon et al.[343], who used non-tailored one-way messages to support adherence to medicines for secondary prevention of cardiovascular disease. Other research developing a one-way text messaging intervention for Type 2 Diabetes[277] may shed light on the role of one-way only text messaging once the evaluation is published.

10.4.2 Tailoring of text messaging content

The systematic review (Chapter 5) found that tailoring interventions may be important for intervention effectiveness (see Section 5.4.2.8) and has widely been discussed for medication adherence interventions[194,256,318,354]. The co-design of intervention concept study included the creation of the TIMELY Personalisation Questionnaire to tailor text messaging

content for Alice. This used the medicines specific scale of the Beliefs about Medicines Questionnaire (BMQ), the automaticity subscale of the Self-reported Habit Index (A-SRHI), and questions on perceived medicine efficacy adapted from work by Phillips et al.[40].

Use of the Medicines-Specific Scale from the BMQ in the context of multiple long-term conditions has found necessity beliefs to be correlated with intentional medication nonadherence[355]. Others have also used the BMQ to tailor content in an online intervention for Inflammatory Bowel Disease[356] and found that it had a positive impact on medication beliefs and medication adherence compared to controls. The live simulation study with patients in my research also found that content selection based on 'raw' BMQ scores may be more appropriate than using the necessity-concerns differential (see 7.4.2.3). This suggests that high concerns scores from the BMQ could dominate perceptions even if patients feel that overall, their medicine need outweighs their concerns. This will be altered for future delivery and evaluation of the TIMELY intervention. Where content tailoring did feel appropriately matched to participants, feedback suggested that Alice seemed to increase motivation to take medicines.

The extent to which beliefs about medication influence medication nonadherence varies between long-term conditions. For example, necessity has been found to have greater influence on medication adherence over concerns in patients with heart failure[280] and in older adults with multiple long-term conditions[355]. Others have found that negative medication beliefs increase when patients report adverse events[357] or where side effects from medicines are more pronounced[40].

Phillips et al.[40] found that reflective motivation factors did not correlate with medication adherence when habit strength was low in patients with diabetes. But that low habit strength was also driven by reflective factors. This suggests that long-term medication-taking could be driven more by habit strength than reflective motivation. Using the A-SRHI, as in TIMELY,

could therefore tailor content based on habit strength, as also suggested in the co-design of intervention concept study and evaluated in the patient simulation study.

Whilst medication monitoring caused patients to evaluate their medication-taking during the short simulation study, whether these reflections will lead to improvements in medication-taking habit is uncertain. The acceptability of more intensive medication monitoring regimes is also unknown. The live simulation study with patients found that those with poorer medication adherence may be more likely to disengage with an intensive intervention. Therefore, this remains an area for further investigation.

There also remains some debate about whether perceived necessity is a separate or overlapping construct with beliefs about medicine effectiveness. In the Personalisation Questionnaire, I separated these using the work of Phillips et al.[40]. However, in their study of Type 2 diabetes, their question on experiential feedback on medicines was correlated with beliefs about medicines and habit strength but did not predict medication adherence outcomes. This was also reflected in their previous work in hypertension[40]. They hypothesized that experiential feedback may be more important in long-term conditions where there is a symptomatic component, and this would be the case in some of the long-term conditions included in the TIMELY intervention. Therefore, it will be important to explore whether perceived effectiveness forms part of a prediction model for medication adherence in a future evaluation of TIMELY.

10.4.3 Behavioural components for inclusion

The systematic review of automated two-way digital communication found four medication-taking behaviours which could be targeted to support medication adherence: obtaining medication, taking medication, self-testing and asking for medication related support (see Section 5.4.2). Evidence on outcomes from included studies and their mechanisms also

highlighted that automated two-way text messaging would likely be best used to increase reflective motivation and promote habit formation for medication-taking.

A more recent study not published when the narrative synthesis was undertaken was a replication of the intervention delivered by King et al.[264] but delivered in the context of tuberculosis treatment in Canada[358]. The original study was difficult to code from a behavioural perspective and was eventually included as the 'Prompts/cues' BCT targeting the behaviour 'Asking for support' and 'Social support (unspecified)' for taking medication. Whilst the original study found an improvement in medication adherence in HIV/ AIDS, this new study found no improvement. This further highlights the importance of identifying mechanisms and contexts to explain potential differences in effect, for what initially appears to be the same intervention. Another study examining an intervention for rheumatoid arthritis found that using the BCT 'Monitoring outcomes of behaviour without feedback' found no improvement in medication or clinical outcomes for patients[359]. This may reinforce the importance of not only monitoring health, but actively communicating the implications of such monitoring to patients to improve medication adherence.

In the SuMMIT-D programme, feedback on behaviour, and feedback on the outcomes of behaviour were omitted from consideration for their intervention. This seemed to be due to the intention to use one-way messages. Yet, in the focus groups for intervention development, participants raised issues around perceived necessity and concerns about the effectiveness of medicines. As a result, the authors concluded that additional BCTs focussing on the consequences of nonadherence could be added, but fell short of suggesting the inclusion of the 'Feedback on the outcome(s) of behaviour' BCT. These BCTs have been found in this research to be potentially important for effectiveness and so the evaluation of this intervention in comparison to TIMELY will offer useful data when published.

An alternative approach to provide feedback on the outcomes of taking medication could have been to deliver the BCT 'Behavioural experiments' which had been proposed in the co-design of intervention concept study. However, the inclusion of this BCT proved unpopular with healthcare professionals (see Section 6.3.5). 'Goal setting' (outcome), 'Review outcome goal(s)' and 'Self-monitoring of outcome(s) of behaviour' were also suggested BCTs for inclusion in TIMLEY in the co-design of intervention concept study. Each of these would require individually tailored outcome goals. Although this is technically possible in the Simple Telehealth software, this was likely a level of detail which would be impractical to deliver, especially in the context of multimorbidity. Also, as many health outcomes have standardised targets, for example, blood pressure ranges, this added level of personalisation may not be necessary and was not present in studies included in the narrative synthesis.

In the SuMMIT-D programme, other BCTs were considered which were not examined in this research. Some of these, such as 'Social comparison', were not found to be favourable in the focus group study in the research programme[318]. Interestingly, the BCT 'Verbal persuasion about capability' was also found in the focus group study to be patronising or simplistic. In the TIMELY intervention this is delivered alongside feedback on behaviour and so becomes targeted at those with poorer adherence.

One area which was not explored in this research is the role of the BCT Salience of consequences. In the co-design of intervention concept study, healthcare professionals were more reluctant to deliver this BCT. In the SuMMiT-D study, patients mentioned this as a potentially desirable BCT, suggesting content similar to the visual images included on cigarette packs[318]. However, the BCT was later removed following review by healthcare providers[342]. In the patient live delivery study, as no patients fell into a tailoring category which would deliver this BCT, its role remains unclear.

10.4.4 Accommodating multiple long-term conditions

The potential behavioural importance of providing feedback on the outcomes of taking medication led to the selection of the eight long-term conditions to be included in TIMELY: asthma, chronic obstructive pulmonary disease, chronic pain, depression, heart failure, hypertension, ischaemic heart disease and type 2 diabetes. These long-term conditions represent some of the highest prevalence diseases in England and as well as morbidity clusters highlighted in the work by others[6,11–14]. No other studies have been found which design or deliver a digital communication intervention for this range of multiple long-term conditions simultaneously.

Content for multiple long-term conditions was developed quickly in this research programme by not performing in-depth evidence examinations of medication-taking barriers for each long-term condition. This is a significant departure from other intervention development. The lack of this examination was also not possible, because there were no pre-selected long-term conditions for inclusion in the intervention. Instead, the selection of conditions and intervention content was based on the systematic review and supplemented with materials from national patient charities, guided by the BCW. This process assumes that the BCW is applicable for all long-term conditions included in the intervention. But this assumption should be explored in future evaluations of TIMELY.

10.5 Delivery of Alice from the community pharmacy setting

The TIMELY intervention is made up of two components, Alice, and the delivery of Alice from community pharmacies. Although a small number of studies in the narrative synthesis systematic review included pharmacist involvement in delivering automated two-way digital communication interventions, TECS has not been widely adopted in this setting. Therefore, the relationship between Alice and the community pharmacy setting was a key line of enquiry throughout this research programme. This included combining Alice with a

pharmacist consultation, training pharmacies to deliver the intervention and collaborating with general practice to support medication-taking.

10.5.1 The enablement consultation

The face-to-face pharmacist 'enablement consultation' aims to resolve barriers to medication-taking which cannot be influenced using two-way automated text messaging. Issues arising from this assessment could be resolved with education, alterations to dispensing, or by liaising with the patients' prescriber. This consultation should therefore deliver the BCW intervention function 'enablement' to perform the behaviours of obtaining and taking medication. Other research has found that community pharmacies can support medication-taking in this way[156] and that face-to-face support seems to be required alongside digital interventions to remove practical barriers to medication-taking[356].

The initial consultation structure using a MUR was used as a basis for gathering feedback in the co-design of intervention concept study (see Section 6.1.4). Feedback on this structure was generally positive and most amendments were focused around ensuring that patients were well informed about how to interact with Alice. For the patient live simulation study, the consultation moved from being an MUR to an 'enablement' consultation (see Section 7.2.2). Analysis of findings from this study suggested that the new enablement consultation seemed to act synergistically with the automated two-way text messaging.

One of the functions of the enablement consultation is to identify and resolve barriers to obtaining medication, reflecting findings from the systematic review (see Section 5.4.2.3). Patient focus groups for the SuMMiT-D intervention also highlighted the importance of obtaining medication, yet there is no coverage of this in the intervention content examples. Obtaining medication was considered in the development of the S-Map study. As pharmacies play an integral role in supporting patients to obtain medication, delivering interventions from this setting naturally support the performance of this behaviour. One

participant in the patient live simulation study also suggested using Alice to support obtaining medication which could be explored in a future iteration of TIMELY.

The enablement consultation is also theorised to remove psychological and physical capability barriers to taking medication. These potential practical barriers to medication-taking are highlighted in the work by Jackson[44] and Horne[38]. Other research has also found that community pharmacies can support medication-taking in this way[156]. Pharmacies are the only service which can make practical changes to medication format such as labels and packaging. They are also closest to the physical medicines to assess issues and identify solutions, such as formulation size, flavour, or colour. However, the extent to which barriers to taking medication are detected and can be resolved should be further explored.

The format of a face-to-face consultation between a patient and a pharmacist has been suggested in other medication adherence interventions, including in the S-Map study. Pharmaceutical care plans have also been evaluated in work by Twigg et al. and found that these services successfully increased patient activation, medication adherence, and quality of life[74]. However, the intervention required 30 minutes of initial time with the pharmacist with a further two instances of 15 minute appointments at interim review points. A similar time commitment is expected for the S-Map intervention. Whilst these interventions may be effective at supporting patients with multiple long-term conditions, the capacity of community pharmacy to deliver such interventions may at present hinder widespread implementation.

This contrasts with an approximate 15 minutes of pharmacist time for the enablement consultation for TIMELY, although the number and length of potential follow-up visits is yet unknown. By delegating the function to increase motivation for taking medication to an automated intervention not requiring human input, this can increase efficiency. Alice should also be able to detect patients who require more support. This way, more intensive

interventions could be targeted at those that need them most and/or when the TIMELY intervention does not work.

10.5.2 Professional acceptability of telehealth delivery

The systematic review found very little evidence available on professional acceptability of telehealth intervention delivery. However, during the co-design of intervention concept study, professional participants could see the potential value in TIMELY. Clinical responsibility for, and appropriateness of text message content, was raised as an issue by participants in multiple studies in this research. This has the potential to affect professional acceptability of the TIMELY intervention as clinical responsibility for text message content would sit with the pharmacy. Testing acceptability of the content with clinical experts may provide some reassurance about the text messaging programme but requires further exploration with pharmacists and pharmacy insurance providers.

10.5.3 Community pharmacy training

The co-design of the pharmacy training study aimed to develop and test prototypes which would support implementation of the TIMELY intervention (see Chapter 8). Delivery behaviours were mapped using the COM-B model, resulting in a suggested eLearning programme, intervention manual and pre-implementation checklist. The seemingly biggest challenge to implementation discovered from this study was the complexity of selecting and personalising the text message protocols in the Simple Telehealth software. This was due to both the volume of potential protocols, and issues calculating ‘Medication Times’ to support medication monitoring. However, the other training components were well received.

10.5.4 Collaboration with general practice

Suggestions for how community pharmacies could collaborate with general practice as part of the TIMELY intervention was explored with the flow diagram for integration in the co-design of intervention concept study and by gaining feedback on communication prototypes

(see Chapter 9). This included a draft notification email to send to GP practices when patients received TIMELY, a mock-up website, and an example text message flow diagram. The tools appeared to clearly communicate their intended messages, however, much of the discussion was dominated by feedback on the intervention itself. The discussion revealed that general practitioners were unsure of the value of the text messaging programme and were concerned about potential increases in their own workload resulting from TIMELY. This emphasised the importance of good working relationships between community pharmacists delivering TIMELY and general practice colleagues.

A qualitative study found that frequency of contact between a regular pharmacist and a regular doctor was thought to be key for supporting patients' medication adherence[330]. Other study authors have included a requirement for general practices to consent to pharmacy service delivery as a pre-requisite[360]. The TIMELY intervention has the potential to act as a conduit for such communication and therefore could potentially improve collaborative relationships between community pharmacies and general practice.

However, work by Rathbone et al.[330] found that community pharmacists in Australia were reluctant to report patients as nonadherent to GPs. This seemed to stem from a feeling that it was the pharmacists' job to support adherence and contacting the GP was admitting professional failure or that GPs were not interested. This may be partly driven by a perception that GPs over-estimate the adherence of their patients. Whether pharmacists in the UK NHS have similar feelings is unknown, though has not been raised as in issue in research around MURs or the NMS.

Other qualitative work has found that pharmacy services with clearly defined boundaries are preferable for multidisciplinary working[331]. As the TIMELY intervention's content varies depending on patient perceptions of medicines and preferences, this had the potential to be a challenge. The co-design of communication tools found that general practices need

reassurance about why the TIMELY intervention is being delivered, what it is intended to achieve, and the role of the community pharmacists as a care coordinator. Further exploration of the communication tools will be important however, due to the small sample in this study.

10.5.5 Community pharmacy context supporting engagement with Alice

The behavioural content developed for Alice will not be effective if patients do not read or reply to the text messages she sends. The patient live simulation study facilitated the development of a realist programme theory for patient engagement with Alice. This was able to confirm that the intervention delivery components created and tested during the co-design of intervention concept study did seem to support engagement. The study also highlighted the importance of the community pharmacy and pharmacist consultation as important contexts for supporting engagement.

The TIMELY intervention capitalises on the established relationship between a community pharmacy and its patients. The increased contact between community pharmacy and their patients[61] enables the building of relationships and trust for patients to reveal nonadherence or ask questions. Standalone digital interventions can suffer with high drop-out rates[356] and poor engagement. Community pharmacies may be better placed to deliver telehealth to support medication-taking than other settings where such technologies have been more widely adopted, such as general practices.

Two interventions developed in parallel to TIMELY have proposed the use of digital communication from the general practice setting to support medication adherence. In the SuMMiT-D intervention development however, patient participants raised concerns about accessibility of general practice for answering queries such as those relating to side effects. Other research has found that care delivery for long-term conditions from community

pharmacies is a desirable option, offering increased accessibility due to the lack of need for appointments and flexible opening hours[331].

There are no recommendations in the NHS for a minimum frequency at which medication review should be performed, and this was highlighted as an uncertainty in the research evidence review for the medicines optimisation guideline developed by NICE[1]. Yet medication-taking is a high-volume behaviour, repeated every day and over long periods of time. It is also subject to change as highlighted in the medication-taking taxonomy developed by Virjens et al.[21]. I see the TIMELY intervention as a way of extending the conversation about medicines between patients and their pharmacist. Others have also highlighted that different stages of medication-taking may present different barriers[354] and the need for continuing assessment of medication-taking issues to support any new needs[361]. The TIMELY intervention could assess need and provide this dynamic support.

10.6 The place of the TIMELY intervention in current healthcare policy

Much has changed since this research programme was planned in 2015/16 and so it is important to consider the intervention in the context of current and future health policy, and what this might mean for the next steps of developing and evaluating the intervention.

10.6.1 The role of pharmacy and pharmacists in the National Health Service

Community pharmacies in the UK NHS are increasingly being recognised for their roles beyond dispensing. Enhanced service provision from community pharmacies has also been found to be cost-effective[52]. Some research has suggested that these extended roles are most acceptable where they are closely linked to medication provision with re-referral to prescribers where required[311]. TIMELY would fit this description. Although MURs were decommissioned in 2020, the New Medicines Service has been expanded with the inclusion of several new long-term conditions[362].

The rationale for the decommissioning of MURs was that medication reviews were best provided in the general practice setting and these have now been commissioned as Structured Medication Reviews (SMRs) for delivery by pharmacists in this setting. SMRs are better placed to review and change medication due to access to the primary care medical records and protected appointment time. However, their purpose is still distinct from that of TIMELY's enablement consultation. Whilst an SMR seeks to ensure that the patient is prescribed the right medicines, TIMELY supports patients to take these medicines. SMRs are also unlikely to be available to everyone and are currently targeted for delivery in specific patient groups[363].

Pharmacists delivering SMRs in general practice could refer patients to a community pharmacy for TIMELY, and community pharmacists delivering TIMELY may identify patients who would benefit from an SMR. Evidence from the NHS NMS and other service pilots have found that pharmacists can have positive impacts on medication adherence by liaising with general practice where drug-related problems are identified[76,340]. These effects may be enhanced where the communication is between two pharmacists in these different settings. Therefore, how TIMELY and SMR provision interact should be subject to future investigation.

There is also opportunity for Alice to be used in a single long-term condition to complement the NMS. There is significant overlap in long-term condition coverage, although timing in relation to NMS components would require further exploration. Especially as automated two-way digital communication interventions for newly initiated medicines seemed to be less effective based on findings from the narrative synthesis systematic review.

10.6.2 The role of technology enabled care services in the NHS

Support for the roll-out of technology in the NHS has accelerated in recent years with the creation of 'NHS X'[363] to support the technology sector to work with the NHS through better

communication and funding opportunities. The TIMELY intervention seeks to introduce TECS to community pharmacies. Whilst this is relatively new to this setting, it is aligned with NHS strategy to make better use of technology to support healthcare provision as outlined in the NHS Long Term Plan[363].

NHS X also supports the use of text messaging as part of healthcare delivery[363] including from community pharmacies[363]. Whilst much of this is one-way, such as notifications for prescription collection, the use of these technologies has been normalised. This provides a strong foundation for interventions such as TIMELY and is likely to be a contributing factor to the good acceptability found in the studies in my research.

10.6.3 Suggestions for the future of the TIMELY intervention

Whilst this research has specifically focussed on the use of TIMELY in the context of the NHS in England, medication nonadherence is a problem globally. Subject to further testing and evaluation, the intervention could be transferable internationally, particularly in high income countries.

The Simple Telehealth software can also facilitate the sending and receiving of text messages in multiple languages, this offers the opportunity to adapt the content for Alice to meet the needs of non-native English speakers. This would need to be subject to further design and testing with these populations but could also offer the opportunity to provide medication-taking support to more underserved communities within the UK.

10.7 Impact of Covid-19 on the research programme and implications for findings

The original programme of research included an additional study to test the feasibility of the TIMELY intervention for study in a randomised controlled trial. Procedures were underway

for approvals when the first lockdown started in the UK in February 2020. When it was clear it would be impossible to complete this study, an alternative study to assess the clinical acceptability of the text message library was designed. However, with the ongoing pressures in the NHS, this was also subsequently deemed unfeasible. Proposals for the clinical acceptability study can be found in Section 10.9.1. However, I now feel that a realistic evaluation is a more appropriate approach to evaluating the effectiveness of the TIMELY intervention, to focus on who the intervention works for an in what circumstances. Suggestions for such an evaluation can be found in Sections 10.9.2 and 10.9.3.

The social distancing measures implemented as part of the COVID-19 pandemic have also led to widespread adoption of various forms of remote healthcare delivery and a move away from pen-and-paper systems. Some of these have implications for TIMELY. One example is the concerns from pharmacists in the co-design of intervention concept study about the verbal consent model for text messaging set-up. In September 2020, a verbal consent model for pharmacy services was introduced[364]. A verbal consent model for the TIMELY intervention should therefore be used in any future roll-out. During the pandemic, mobile phone ownership and use of text messaging also increased by almost 10%[365] suggesting that the TIMELY intervention is even more accessible.

With NHS waiting times at a record high[366], it has never been more important to keep patients out of hospital unnecessarily. This can be achieved by keeping patients well by optimising health at home. Adherence to medicines is a key part of that picture and the TIMELY intervention has the potential to support this.

10.8 Implications for practice

The process of developing the TIMELY intervention provides insights on how similar interventions should be designed in the future.

10.8.1 Digital communication intervention design for complex healthcare interventions

The framework for developing digital healthcare interventions described by Abroms et al.[141] and the updated MRC Complex Intervention Development guidance[144] both prompt intervention designers to ask important questions covered in this research process. The HCD process described by IDEO.org[163] supplements this guidance by providing a flexible and practical toolkit of ideas and offers greater insight into which feedback is needed to support intervention design and why. The IDEO.org toolkit is also broad enough in scope to consider how complex interventions containing multiple elements (for example digital healthcare interventions and additional components). Future intervention developers should therefore consider using all three guidance documents to create bespoke development pathways which suit the needs of the specific complex digital health interventions they are seeking to develop.

Designers also need to be aware about how their choice of technology platform affects what behavioural strategies they can use and the accessibility of their interventions. For example, as discussed in Section 10.4, selecting only one-way communication will limit the BCTs which can be included. Using text messages with hyperlinks also assumes that the end user's mobile phone can be used to browse the internet. Those designing digital communication as part of complex healthcare interventions therefore need to consider who their interventions are designed for and how they are expected to work.

10.8.2 Medication adherence intervention design

Many have criticised the development of interventions for medication adherence for under-estimating the complexity of medicines-taking[49,361] and the narrative synthesis systematic review findings reinforce this argument. The work by Abroms et al.[141], although not specific to medication adherence, emphasises the need for digital communication interventions to be guided by the behavioural problem, rather than the possibilities of the technology. However, there is an additional layer of complexity to medication-taking as a health behaviour which I

believe continues to be under-recognised. In particular, the multiple behaviours which are required and the large variation of influences on these between individuals.

The step of identifying and defining the behaviour to be targeted should be further promoted in descriptions using the BCW, especially when used for medication-taking. Medication-taking should be seen as a series of inter-linked behaviours. Researchers examining these behaviours and seeking to influence them should be specific about which behaviours are being examined or targeted, and why. This could involve identifying other behaviours or further breaking down the parent behaviours described in this research. For example, “taking medication” using an inhaler requires a series of smaller behaviours such as “shaking the inhaler” which could also be targeted for intervention.

I would also caution against using some aspects of the BCW in isolation. For example, researchers often use the BCT Taxonomy independently of other elements of the process. This seems to repeatedly result in authors creating ‘new’ BCTs, rather than differentiating BCTs from aspects of delivery, the intervention function or COM-B component which the BCT is attempting to influence. Some of this practice may shift with the progress of the Human Behaviour Change[367] project led by University College London, which is developing additional taxonomies for behavioural mechanisms[368] and intervention delivery[369].

10.8.3 Using the Simple Telehealth platform

This research offers an example of the breadth of functionality that the Simple Telehealth platform can deliver using text messaging. The delivery model for the software platform is to provide a ‘ready-made’ environment for healthcare professionals to design TECS pathways for their own setting. The most recent version offers the potential for sophisticated automated two-way communication to support the clinical care delivery. Those using this system should be encouraged to use a theoretically informed approach to designing

pathways and ensure that they have a good understanding of system capabilities to optimise the creation of protocols.

Existing guidance from Simple Telehealth should also be highlighted. Simple Telehealth recommends use of a persona for text message communication, starting with Florence and for TIMELY, Alice. The aim of both personas is to support patients to take responsibility for self-care by promoting health behaviour change. Alice was grounded in the experience of Florence. In this research, I have added to the evidence for this approach. Use of a persona seems to be a mechanism to support engagement with text messaging and should continue to be used both within the Simple Telehealth community, and potentially adopted for other automated two-way digital communication interventions. However, the context of intervention delivery should also be acknowledged, and these personas seem to be given 'life' when used in combination with support from real healthcare professionals.

10.9 Future research recommendations

Learning from the development of the TIMELY intervention highlights several potential areas for future research, including: questions for further development of the intervention, understanding implementation and effectiveness, and broader questions about how we support people to take medicines.

10.9.1 Clinical acceptability of text messaging content

Because the text messaging protocols in Alice are designed to be standardised nationally, a further challenge remains to ensure that their structure is acceptable to clinicians. Whilst the content is behaviourally robust, decisions about whether the results of patient health monitoring represent 'stable, 'improving' or 'deteriorating' health should be further explored from a clinical perspective. This is because although some home monitoring, such as blood pressure, is relatively well established, much of the content developed for TIMELY represents adaptations from other available tools. This assessment needs to be framed in

the context of providing feedback to patients on their medicines, rather than diagnostic or clinical monitoring purposes. It is also important that such monitoring does offer safety netting to ensure patients who require active intervention are identified.

To ensure that this standardisation of protocols is appropriate, a study using a method similar to a content validity study for questionnaires could be used[370]. This would quantify agreement about text message content suitability and could be supplemented with qualitative data collection to understand how best to amend text messages. Such clinical evaluation would also likely improve the perceived quality of the text messaging programme to increase acceptability of the TIMELY intervention to pharmacy and wider primary care teams.

10.9.2 Realistic evaluation to understand patient level outcomes, mechanisms and contexts to support medication-taking

Many reviews of interventions to support adherence to medicines have highlighted a need to establish which interventions and which components of interventions are most effective[53]. Other studies of digital communication interventions for medication adherence have also highlighted that some populations are more likely to benefit from use of these technologies than others[111–113,115,118,318]. A realistic evaluation approach (see Section 4.3) would be able to address these questions and would offer a novel approach to assessing the effectiveness of complex interventions for medication adherence. The third iteration programme theory which has been developed in this research provides a good starting point for exploring TIMELY in a larger sample of patients and from a greater variety of contexts.

Identifying outcomes from text messaging with Alice would be an important consideration for any future realistic evaluation. There is no ‘gold standard’ for measuring medication adherence in the context of polypharmacy, and so current recommendations are to use multiple measurement methods to achieve this[27]. A recent report from the Department of

Health in England has also recently estimated that up to 10% of medicines are also prescribed unnecessarily[286]. Many studies looking to improve medication adherence have not accounted for this, and the result could be that patients have improved adherence to unnecessary medicines. The TIMELY intervention tackles this by using text message content to encourage patients to discuss medicines with the pharmacist if patients feel that medicines are not needed. Therefore, the intervention could also influence changes to patients' medication as an outcome which should also be explored.

Outcomes should then be explored for causative mechanisms. This could include the varying contribution of different BCTs. Although the narrative synthesis systematic review was able to directly compare some BCTs, such as providing 'Feedback on outcomes of behaviour' compared to 'Monitoring outcomes of behaviour without feedback', other BCTs comparisons were not possible. The relative importance of different behavioural mechanisms should be explored. This is particularly challenging given the large volume of potential mechanisms of action interacting within the intervention.

With a large sample size, a sufficiently powered quantitative study could detect and measure the relative effects of these differing mechanisms of action on medication adherence and clinical outcomes by examining the correlation between quantifiable mechanisms and measured adherence. For example, changes in the necessity-concerns differential and medication adherence. Similarly, scores for perceived effectiveness of medication and habit strength as predicted by the TIMELY programme theory. Strength and direction of correlation would indicate whether the predicted mechanisms are working as expected to influence perceptions, and subsequently medication adherence, and ultimately clinical outcomes.

An alternative could be to randomise participants to versions of the intervention with varying mechanism components, such as used in Sequential Multiple Assignment Randomized

Trials[371]. As this method is used to develop adaptive interventions, this would also support answering questions pertaining to the use of the personalisation questionnaire and score thresholds for tailoring the behavioural content of text messages. This could inform changes to the thresholds and/or the inclusion of additional instruments or questions and/or removal of questions to better match patients to the content which feels most appropriate to them. And advantage of this approach is that it could also measure effectiveness rather than being limited to assessing correlation.

Quantifying the effects of the behavioural mechanisms would also inform whether the intervention might be transferable to other long-term conditions. The long-term conditions included in this first version of the TIMELY intervention were limited by the ability to provide feedback on medicines effectiveness. Depending on the relative importance of this behavioural mechanism, Alice's content could be extended to other medicines and long-term conditions. The patient participant with Parkinson's Disease in the simulated delivery study, for example, seemed to gain more benefit from the medication reminders over the chronic pain content they received.

Where mechanisms and outcomes are not aligned as expected, contextual factors can then be explored. For example, Nundy et al.[262] identified moderators of their proposed behavioural mechanisms by interviewing patients who had received the intervention. Relationships between the patient and the community pharmacy[331] and pharmacy ownership model[83] have also been found to influence the outcomes from pharmacy interventions and may do so also with the TIMELY intervention. Such interviews could also identify further unknown mechanisms which are created within the intervention, including those which could be increasing medication non-adherence, counter to the intended outcome. There would also be benefit to interviewing study participants whose outcomes seem to 'fit' the predicted mechanistic model to confirm that the programme theory is accurate and to identify optimal contextual factors for achieving the intended outcomes.

A realistic evaluation would ultimately lead to a final version of the TIMELY programme theory and could support the generation of commissioning recommendations for the NHS. It could also identify where alternative medication adherence interventions are needed to suit the varying needs of patients in relation to medication support.

10.9.3 Delivering Alice from the community pharmacy setting

This research has provided a starting point for how Alice can be delivered from a community pharmacy setting and developed training which needs to be delivered to ensure successful implementation. However, future research should include process evaluations to explore how best to support community pharmacy teams to adopt and deliver the intervention. This would include training to deliver the enablement consultation as this did not form part of the simulated pharmacy training study.

Impact on pharmacy workloads to deliver the TIMELY intervention was a consistent feature of feedback across all studies. This is a concern that has been expressed in other studies exploring stakeholders' views of providing extended community pharmacy services on top of the core medicine supply activity[331]. Therefore, the amount of time required for pharmacist input requires careful consideration. The consultations for the simulation study with patients were not recorded, so there is not any accurate data on their length. Monitoring enablement consultation duration alongside volume and time spent on follow-up queries should be monitored as part of any future implementation to assess impact on pharmacy workload.

To reduce pharmacist time burden, one option could be to involve the pharmacist in only the medicines review component of the intervention. Pharmacy support staff could then be trained to deliver other elements associated with setting up patients on the Simple Telehealth system and counselling the patient on how to interact with Alice. However, as findings from the patient simulation study suggested that the consultation was an important

mechanism for supporting engagement with Alice, the potential impact of reducing time with the pharmacist would need to be explored.

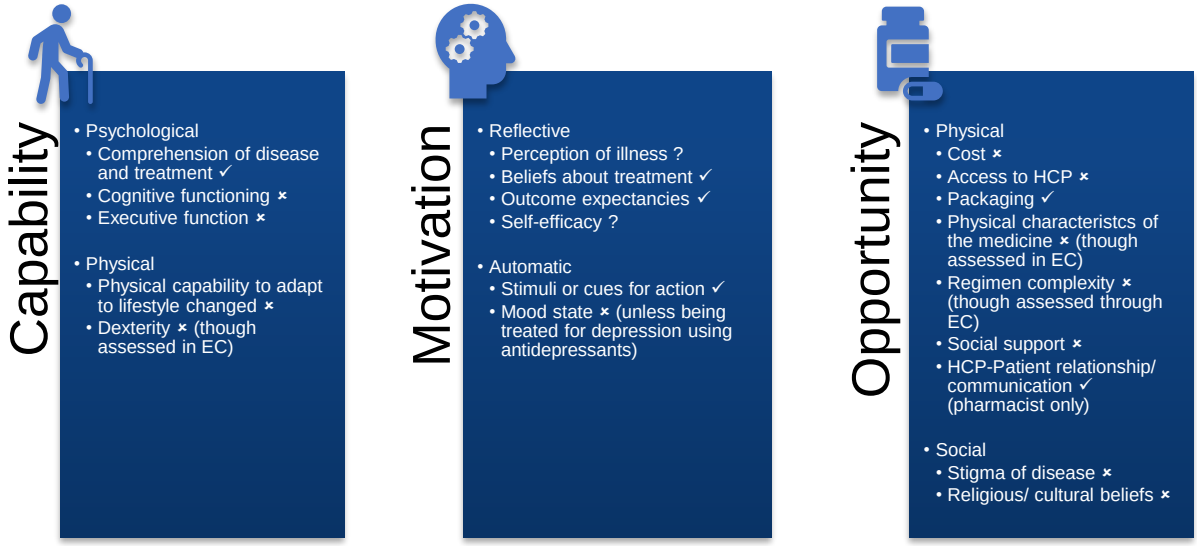
In the simulated training with community pharmacy, the task which took up the most time was that of selecting and personalising the text messaging protocols in the Simple Telehealth software. The difficulties were not because of the software *per se*, but because of the complexity of the intervention itself. However, as this is a technical process it does not need to be completed by a pharmacist. Other options could be for the pharmacy to refer this process to a centralised point, for example someone trained in a head office environment, Primary Care Network or parent provider, such as Pharmaceutical Services North East[372]. An alternative would be to integrate Simple Telehealth with other software already in use in community pharmacies such as PharmOutcomes or Pharmacy Medication Record systems.

As well as potential workload challenges, consistency of workforce has also been found to be important for delivering extended community pharmacy services[331]. Continuity of care seems to be important when providing support for long-term conditions from a community pharmacy setting[329]. This may be an important contextual factor to consider for future evaluation of TIMELY.

A non-pharmacy challenge to the implementation of TIMELY will be the availability of home monitoring equipment for patients. As this monitoring provides potentially important behavioural mechanisms, how patients might access this equipment will need to be considered as part of any future implementation. As it is unknown what length of intervention is required to improve and maintain medication-taking or the relative importance of this behavioural mechanism the solution to this challenge is also unclear.

10.9.4 The place of TIMELY as an option to support medication adherence

No one intervention can support all issues associated with medication-taking and this has been highlighted by others[49]. Using the work by Jackson et al.[44], aspects of COM-B the TIMELY intervention may address are highlighted in Figure 31. There are influences on health and medication-taking which the TIMELY intervention does not address, however. Patients with moderate or severe cognitive impairment for example are unlikely to benefit from the TIMELY intervention due to issues around the ability to make and execute behavioural plans. These patients may benefit more from carers to support with medication-taking for example.



✓ = Influenced through the TIMELY intervention; × = Not influenced through the TIMELY intervention;
? = Unclear if these will be influenced through the TIMELY intervention; EC= Enablement Consultation

Figure 31 The COM-B model mapped to medicines taking as described by Jackson et al. (2015) with TIMELY intervention mechanisms added

There are a range of other medication-taking interventions that are likely to be more effective than TIMELY, such as motivational interviewing[373]. There is good evidence that pharmaceutical care plans can create more positive beliefs about medicines and improve medication adherence[73,74,360]. There will also be a cohort of people who refuse to take medicines, and here the focus should be on ensuring that this is an informed decision, rather than continuing to encourage adherence.

Future research needs to focus not just on creating interventions and evaluating them for effectiveness, there also needs to be effort concentrated on understanding for whom interventions work. In the longer term, research needs to establish ways of matching support needs to intervention types, of which there will likely be many. TIMELY can be tailored to practical and perceptual barriers to medication-taking for those with the cognitive and physical skills to self-manage medication-taking and can use text messaging. However, this is just one cohort of patients who need to take medicines. More intensive interventions could be reserved for patients where either the consequences of nonadherence have heightened impact on the individual or wider society, such as in HIV/ AIDS or where lower resourced interventions, such as TIMELY, do not work. Uncovering who the TIMELY intervention may help, and under what circumstances, is an important part of understanding how the TIMELY intervention fits in to a larger strategy of supporting medication adherence.

There is also increasing interest in how data are harnessed to better understand patient behaviours, health outcomes, and improve healthcare delivery at the system as well as the individual level. Pharmacy data at present remain unintegrated within the wider healthcare system. The two-way nature of the data collected in the Simple Telehealth system would create an additional health dataset which may be useful to further understand medication adherence. However, how this information is presented, who should have access to it and what the outcomes would be, needs further investigation. A Cochrane review of providing data on medication nonadherence to general practitioners[374] found limited evidence that it results in improvements to patient outcomes. However, providing feedback to pharmacists on medication nonadherence does not yet seem to have been studied.

Chapter 11 Conclusion

This research has shown that patients and professionals can be involved in a co-design process to develop an automated two-way text messaging intervention and its delivery from a community pharmacy setting. Although subject to further evaluation, a structure and content for a text messaging intervention to support multiple long-term conditions has been successfully developed. Initial work with patients and healthcare professionals has found that combining automated two-way text messaging and community pharmacy support has good acceptability. The behavioural approach also seems to potentially increase motivation to take medicines, which should lead to improved medication adherence.

Supporting pharmacies to deliver Technology Enabled Care Services is also an important area to explore. With widespread digital adoption resulting from the COVID-19 pandemic, investment in technology and community pharmacy in the NHS, the time is right for Technology Enabled Pharmaceutical Care. Alice, as part of the TIMELY intervention, is a fantastic starting point for this journey.

Medication adherence remains a complex problem for healthcare, and no one solution will support everyone. Text messaging will only be suitable for those who use and are comfortable with this technology. But where patients need or want support for medication-taking, and the use of text messaging is feasible, then the TIMELY intervention has the potential to help.

This research has started the process to discover what Technology Enabled Pharmaceutical Care should look like to support medication adherence, how it might work, where it should be delivered and for whom. The goal should now be to answer these important questions to guide commissioning decisions for TIMELY's future delivery in the NHS and beyond.

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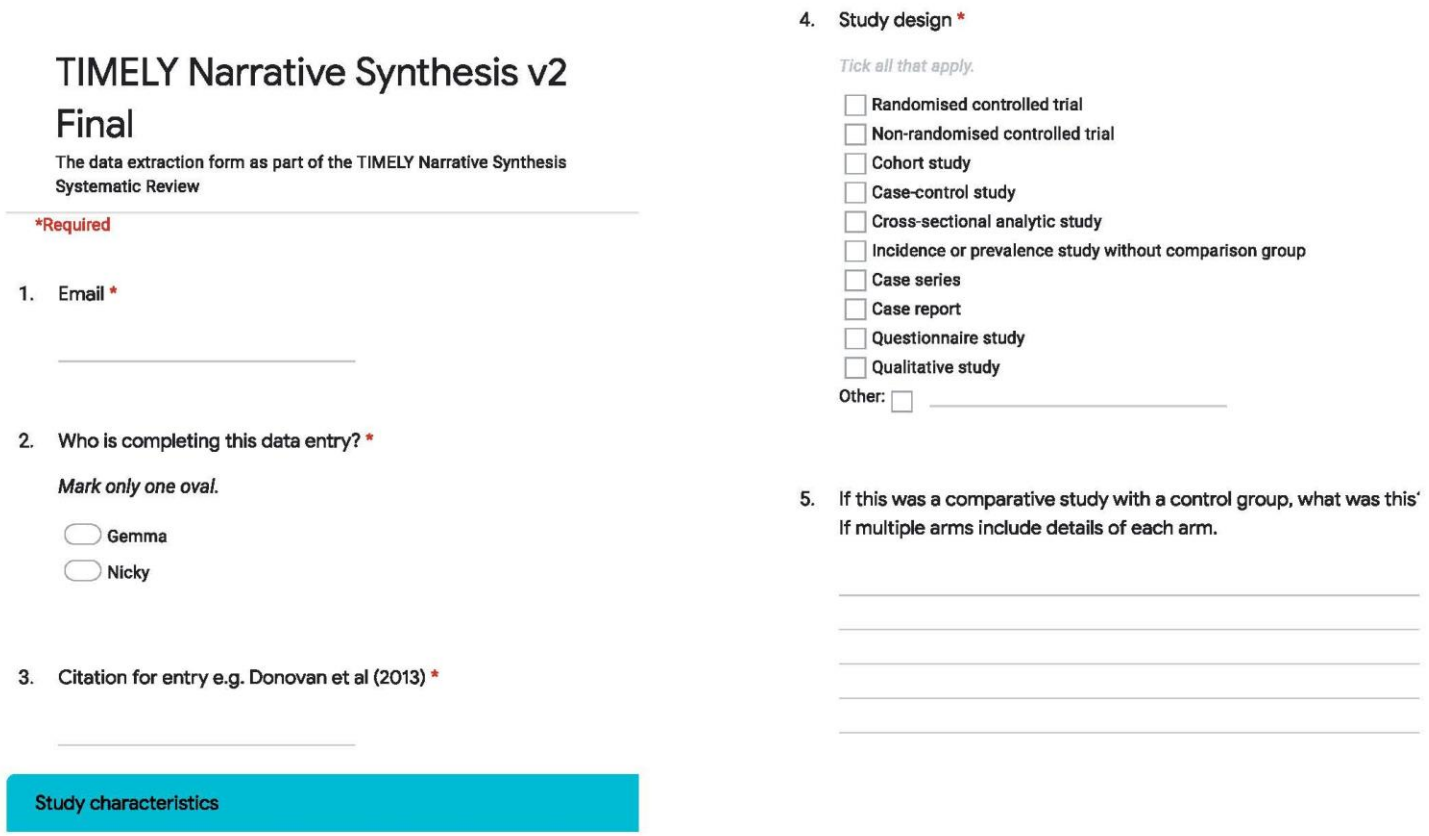
Appendices

Appendix 1 Data extraction form for narrative synthesis systematic review



TIMELY Narrative Synthesis v2 Final

The data extraction form as part of the TIMELY Narrative Synthesis Systematic Review

*Required

1. Email *

2. Who is completing this data entry? *

Mark only one oval.

- Gemma
- Nicky

3. Citation for entry e.g. Donovan et al (2013) *

Study characteristics

4. Study design *

Tick all that apply.

- Randomised controlled trial
- Non-randomised controlled trial
- Cohort study
- Case-control study
- Cross-sectional analytic study
- Incidence or prevalence study without comparison group
- Case series
- Case report
- Questionnaire study
- Qualitative study

Other:

5. If this was a comparative study with a control group, what was this'
If multiple arms include details of each arm.

6. Select country of intervention *

Mark only one oval.

- Australia
- Austria
- Belgium
- Canada
- Chile
- China
- Croatia
- Cyprus
- Czech Republic
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Iceland
- Ireland
- Israel
- Italy
- Japan
- Korea, Rep.
- Latvia
- Lithuania
- Luxembourg
- Malta
- Monaco
- Netherlands
- New Zealand
- Norway
- Poland
- Portugal
- Puerto Rico
- Qatar
- Saudi Arabia
- Singapore
- Slovak Republic
- Slovenia
- Spain
- Sweden
- Switzerland
- United Arab Emirates
- United Kingdom
- United States
- Other

7. Date of study recruitment or "Not given" e.g. July 2010 *

8. Date of study close (until final follow-up) or "Not given" e.g. July 2011 *

9. Any other significant dates of interest? Please state date with description.

Participant characteristics

10. Number of participants included in the study or "Not given" *

11. Age of participants as Mean (SD) for total population or "Not given" *

12. Age of participants as Min-Max e.g. 18-24 or "Not given" *

13. What was the native language(s) of the participants? *

Tick all that apply.

- [ ] English
- [ ] French
- [ ] Spanish
- [ ] Unclear
- [ ] Other:

14. Long term conditions included within the study *

Tick all that apply.

- [ ] Acne
- [ ] Anxiety disorders
- [ ] Asthma
- [ ] Atrial fibrillation
- [ ] Cancer
- [ ] Cardiovascular disease/ Ischaemic heart disease/ ACS/ MI/ Angina
- [ ] Chronic Obstructive Pulmonary Disease
- [ ] Dementia
- [ ] Depressive disorders
- [ ] Diabetes
- [ ] Epilepsy
- [ ] Glaucoma
- [ ] HIV/ AIDS
- [ ] Heart failure
- [ ] Hypertension
- [ ] Inflammatory bowel disease
- [ ] Organ transplantation
- [ ] Osteoporosis
- [ ] Pain (chronic)
- [ ] Parkinsons' dissease
- [ ] Psoriasis
- [ ] Rheumatoid arthritis
- [ ] Schizophrenia
- [ ] Stroke

Other: [ ] _____

15. Was the intervention targeted at any particular participant characteristic e.g. sociodemographic group? or "Not targeted" *

_____

_____

_____

_____

_____

16. Was there any significant participant characteristic which was excluded e.g. patients with mental health problems? or "No significant exclusions" *

_____

_____

_____

_____

_____

17. Percentage of females included in the study or "Not given" *

_____

18. Any other information about the participant characteristics which may be relevant?

Intervention characteristics

19. Technology used *

Mark only one oval.

- IVR
- SMS
- Pager device
- Other: _____

20. What language(s) was the intervention delivered in? *

Tick all that apply.

- English
- French
- Spanish
- Unclear
- Other: _____

21. Intended outcomes of the intervention in relation to medication adherence *

Tick all that apply.

- Promote medication adherence to a new therapy
- Maintain medication adherence to an established therapy
- Improve medication adherence to an established therapy
- To identify potential barriers to medication adherence
- To detect medication non-adherence
- Unclear
- Other: _____

22. Where there any additional intended outcomes of the intervention in relation to self-management of long term condition? For example improving knowledge, quality of life, self-efficacy, healthcare service utilisation or "No additional intended outcomes *

23. How long was the intervention? (Weeks/Months) or "Unclear" *

24. Did the intervention claim to be "tailored" or "personalised"? *

Tick all that apply.

- [ ] Personalised by using the patients' name in messages
- [ ] Personalised as patients' could choose when messages were sent
- [ ] Personalised as patient chose the message that they received e.g. designed the text
- [ ] Tailored to patients' identifiable barriers to medication adherence
- [ ] Tailored to patients' identifiable needs to facilitate self-care for their long term condition
- [ ] Describes tailoring or personalisation but unclear how this has been achieved
- [ ] No personalisation or tailoring
- [ ] Other: _____

25. Did the intervention include a "reminder"? *

Tick all that apply.

- [ ] General reminder to adhere to medicines e.g. It is important to take your medicines every day
- [ ] Prompt reminder e.g. It's time to take your blood pressure medicines
- [ ] Monitoring reminder e.g. Did you take your blood pressure tablet today
- [ ] Yes, but it's unclear which type of reminder
- [ ] No reminder

26. How frequent was the communication intended to be e.g. daily, weekly or "Unclear frequency" *

_____

27. How was the communication for the intervention initiated? *

Mark only one oval.

- ◯ Intervention initiated by the intervention deliverer e.g. healthcare profession, research team
- ◯ Intervention initiated by the patient e.g. by ringing a phone number or texting
- ◯ Intervention initiated by the intervention deliverer but patients could also initiate
- ◯ Intervention initiated by the patient but intervention could also initiate where patients do not respond
- ◯ A mixture of patient and intervention deliverer intiation
- ◯ Unclear

28. How frequently is the patient expected to interact with the intervention? e.g. Daily or "Unclear frequency" *

_____

29. Are there any other technology elements included in the intervention? *

Tick all that apply.

- [ ] None
- [ ] Blood pressure monitoring
- [ ] Weight monitoring
- [ ] Pedometer
- [ ] Blood glucose monitoring
- [ ] Peak flow measurement
- [ ] Oxygen saturation
- [ ] Pulse monitoring
- [ ] Other: _____

30. Are there any other additional communication components to the automated intervention? *

Tick all that apply.

- [ ] None
- [ ] Face-to-face consultations
- [ ] Website based content
- [ ] Synchronous telephone calls
- [ ] Videoconferencing
- [ ] Printed materials (please specify)
- [ ] Other: _____

31. If printed materials were provided please provide details here

_____

32. Were there any other non-communication components to the intervention e.g. creation of a shared management plan? *

_____

33. To what extent is the content of the intervention available? *

Mark only one oval.

- ◯ Examples are provided
- ◯ The full content is available e.g. as a downloadable file
- ◯ Only a description of the content is available

34. Any other relevant information about the intervention design

_____

_____

_____

_____

_____

Intervention delivery characteristics

35. Setting for sites involved in intervention delivery *

Tick all that apply.

- [ ] General practice
- [ ] Community based care e.g. Distric Nursing
- [ ] Out-patient care
- [ ] Community pharmacy
- [ ] Academic
- [ ] Non-health community setting
- [ ] Unclear
- [ ] Other: _____

36. Number sites involved in intervention delivery or "Unclear" *

_____

37. Software/ system used for automated patient contact delivery or "Unclear" *

_____

38. Were sites remunerated for to cover the additional costs of the intervention compared to usual care? e.g. text messages, telephone calls *

Mark only one oval.

- ◯ Yes, fully
- ◯ Yes, partially
- ◯ No
- ◯ Not applicable
- ◯ Unclear

39. Were sites remunerated for the cost of the staffing time to delive the intervention? *

Mark only one oval.

- ◯ Yes, fully
- ◯ Yes, partially
- ◯ No
- ◯ Not applicable
- ◯ Unclear

40. Were patients provided with equipment to participate in the intervention? e.g. mobile phone, pedometer *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Unclear

41. If equipment was provided, what was this?

_____

42. Does the paper state that the costs for participants to communicate with the intervention were covered by the study? *

Mark only one oval.

- ◯ Yes
- ◯ No

43. 'Who' was communicating using the intervention *

Tick all that apply.

- ☐ Unclear
- ☐ Patients' own GP
- ☐ Patients' own primary care nurse
- ☐ Patients' own community pharmacist
- ☐ Specialist from secondary care (any profession)
- ☐ Researcher
- ☐ Persona based communication e.g. Flo

Other: ☐ _____

44. Any other relevant information about the intervention delivery

_____

_____

_____

_____

_____

Outcomes of study

45. What were the intended outcomes of the study? *

_____

_____

_____

_____

_____

46. Was clinical control measured as part of the study outcomes? e.g blood pressure *

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 51*

Clinical Outcomes

47. What clinical outcomes were measured? e.g. blood pressue

48. At what time points was this measured? e.g. 0, 6 weeks

49. Did the study authors conclude that results support use of the intervention?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Unclear

50. Which outcome did they use to support this conclusion?

Outcomes of Study (Medication)

51. Was medication adherence measured as part of the study outcomes? *

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 56*

Medication Adherence outcomes

52. How was medication adherence assessed?

Tick all that apply.

- ☐ Pill count
- ☐ Validated questionnaire tool e.g. Morisky
- ☐ Electronic container opening e.g. MEMS
- ☐ Medication supply data e.g. prescription refills
- ☐ Biochemical assay e.g. Drug level in blood
- ☐ Medication diary
- Other: ☐

53. At what time points was this assessed? e.g. 0, 6 weeks

54. Did the study authors conclude that the results support use of the intervention?

Mark only one oval.

- ◯ Yes
- ◯ No

55. What outcome did they use to support this conclusion?

Study outcomes (patient acceptability)

56. Was patient acceptability assessed as part of the study outcomes? *

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 59*

Patient Acceptability Outcomes

57. How was patient acceptability assessed?

Tick all that apply.

- ☐ Retention in the study e.g. not opting out
- ☐ Engagement in the study e.g. responding to text messages
- ☐ Quesionnaire
- ☐ Interviews
- ☐ Focus groups
- Other: ☐

58. Provide a short summary of their findings from assessing this

Study outcomes (professional acceptability)

59. Was professional acceptability assessed as part of the study outcomes?

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 62*

Professional Acceptability Outcomes

60. How was professional acceptability assessed?

Tick all that apply.

- [ ] Retention in the study e.g. not opting out
- [ ] Engagement in the study e.g. number of patients signed up
- [ ] Quesionnaire
- [ ] Interviews
- [ ] Focus groups
- [ ] Other: _____

61. Provide a short summary of their findings from assessing this

_____

_____

_____

_____

_____

Study Quality Assessment

62. Is the study a mixed methods study incorporating qualitative and quantitative data? *

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 67*

Mixed methods study

63. Is the mixed methods research design relevant to address the qualitative and quantitative research questions?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

64. Is the integration of qualitative and quantitative data relevant to address the research question?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

65. Is appropriate consideration given to the limitations associated with this integration?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

66. Any comments on the mixed methods approach

Quantitative studies

Non-randomised study types include non-randomised controlled trials, cohort studies, case-control studies, cross-sectional analytic studies.

67. Does the study include a comparative element? *

Mark only one oval.

- ◯ Randomised controlled trial
- ◯ Non-randomised controlled trial *Skip to question 76*
- ◯ No comparative element *Skip to question 86*
- ◯ Other:

Quantitative (randomised controlled trial)

68. Provide a brief description of this data.

69. Is there a clear research question?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

70. Do the collected data address the research question?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

71. Is there a clear description of the randomisation?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

72. Is there a clear description of the allocation concealment?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not applicable
- ◯ Can't tell

73. Are there complete outcome data (80% or above)?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

74. Is there a low withdrawal/drop-out (below 20%)?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

75. Do you have any comments you wish to add?

_____

_____

_____

_____

_____

Skip to question 86

Quantitative (non-randomised trial)

76. Provide a brief description of this data.

_____

_____

_____

_____

_____

77. Is there a clear research question?

Mark only one oval.

- Yes
- No
- Can't tell

78. Do the collected data address the research question?

Mark only one oval.

- Yes
- No
- Can't tell

79. Are participants (organisations) recruited in a way that minimises selection bias?

Mark only one oval.

- Yes
- No
- Can't tell

80. Are measurements appropriate regarding the exposure/intervention and outcomes?

Mark only one oval.

- Yes
- No
- Can't tell

81. In the groups being compared, are the participants comparable, c do researchers take into account the difference between these groups?

Mark only one oval.

- Yes
- No
- Can't tell

82. Are there complete outcome data (80% or above)?

Mark only one oval.

- Yes
- No
- Can't tell

83. If applicable, is there an acceptable response rate (60% or above)

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell
- ◯ Not applicable

84. If applicable, is there an acceptable follow-up rate for cohort studies?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell
- ◯ Not applicable

85. Do you have any comments you wish to add?

Quantitative studies

This includes prevalence studies, case series, case reports, questionnaire methods.

(descriptive)

86. Does the study have a quantitative descriptive element? *

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 95*

Quantitative (descriptive)

87. Provide a brief description of this data.

88. Is there a clear research question?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

89. Do the collected data address the research question?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

90. Is the sampling strategy relevant to address the research question?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

91. Is the sample representative of the population under study?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

92. Are measurements appropriate?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

93. Is there an acceptable response rate (60% or above)?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

94. Do you have any comments you wish to add?

_____

_____

_____

_____

_____

Qualitative studies

Includes ethnography, interviews, focus groups.

95. Does the study have a qualitative component? *

Mark only one oval.

- ◯ Yes *Skip to question 96*
- ◯ No

Qualitative study

96. Provide a brief description of this data.

97. Is there a clear research question?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

98. Do the collected data address the research question?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

99. Are the sources of qualitative data relevant to address the research question?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

100. Is the process for analyzing qualitative data relevant to address the research question?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't tell

101. Is appropriate consideration given to how the findings relate to the context in which the data were collected?

Mark only one oval.

- Yes
- No
- Can't tell

102. Is appropriate consideration given to how the findings relate to researchers' influence through their interactions with participants?

Mark only one oval.

- Yes
- No
- Can't tell

103. Do you have any comments you wish to add?

Appendix 2 Personalisation questionnaire (version 1) prototype

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Flo says Hello!

Flo would like to help you with your medicines. To do this in the best possible way, she'd like to know a bit more about you.

We'll start with some basic information, then ask you what you think about your medicines at the moment.

Once you've completed the questionnaire, the pharmacist will take you into the consultation room to get you set up. Flo will take it from there.

Don't worry, all of your information will be stored securely in the pharmacy and won't be shared with anyone else, unless you want to share it by giving them your mobile phone number. You're in control.

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University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

1. **Are you able to send and receive text messages on your mobile phone?**

Yes ☐ No ☐ Unsure ☐

2. **Do you have difficulty getting signal on your mobile phone for most of the day?**

Yes ☐ No ☐ Unsure ☐

3. **How do you pay for your mobile phone?**

Pay as you go ☐ Phone contract with a text message bundle ☐ Phone contract without a text message bundle ☐

4. **What long term conditions you have that you take medication for?** (Please tick all that apply)

Angina ☐	Chronic pain ☐
High blood pressure ☐	Asthma ☐
Heart failure ☐	COPD (also known as bronchitis or emphysema) ☐
Type 2 Diabetes ☐	Depression ☐

5. **If you have any other long term conditions not listed above, list them here.**

_____

_____

6. **What times of the day are you prescribed medicines?**

Morning ☐	Evening ☐
Lunchtime ☐	Night time ☐

7. **Do you have any of the following equipment at home?**

Blood pressure monitor	☐	Thermometer	☐
Blood glucose monitor	☐	Weighing scales	☐
Oxygen reader	☐	Peak flow meter	☐

8. **Please tick (✓) the column that best represents your response to the following statements**. There are no right or wrong answers, Flo is just interested in your honest views. Please consider your answers for all of the medicines that you take.

Statement	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Medication-taking is something that I do without thinking					
My health, at present, depends on my medicines					
Having to take medicines worries me					
My life would be impossible without my medicines					
Without my medicines I would be very ill					
I sometimes worry about the long-term effects of my medicines					
I have noticed the positive benefits of taking my medication					
I take my medicines without having to consciously remember					
My medicines are a mystery to me					
My medicines disrupt my life					
I sometimes worry about becoming too dependent on my medicines					

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

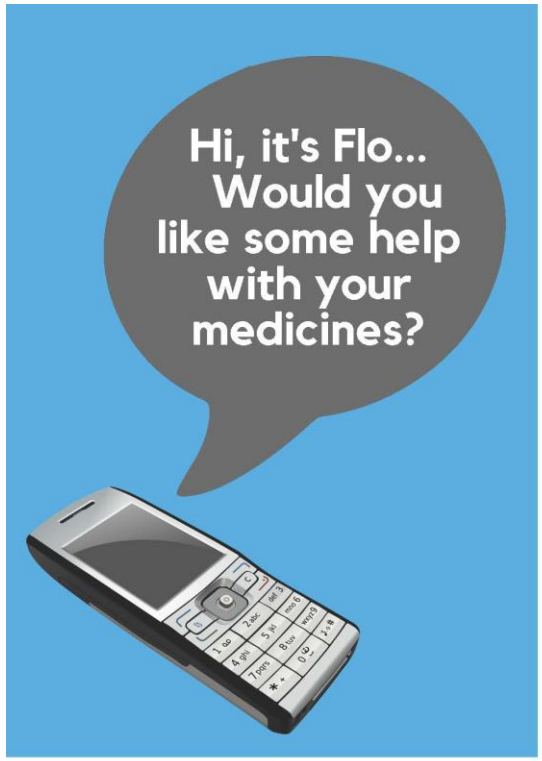
Statement	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I start taking my medication before I realise I'm doing it					
My medicines protect me from becoming worse					
My health in the future will depend on my medicines					
I have experienced solid/ convincing evidence that my medication does what it is supposed to do					
Medication-taking is something that I do automatically					

9. **Are you happy for the pharmacy to use the list of medicines in their records to set up the right text messages for you to receive?**

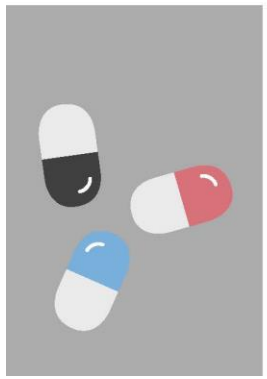
Yes ☐ No ☐

Now please hand your form back to the pharmacy team.

Appendix 3 TIMELY patient information leaflet (version 1) prototype



NHS
Sunderland
Clinical Commissioning Group



"Florence" or "Flo" as we like to call her, is a very easy to use service designed by professionals inside the NHS to provide support and advice for you to manage your medicines and conditions.

About Flo

Flo combines the expertise of your pharmacy team and the convenience of your own mobile phone to give you tailored information and advice about your medicines.

Depending on what support might help you, she also might ask you to monitor your health such as taking your blood pressure.

Flo uses the familiar mobile phone text service "SMS" to communicate with you directly.

Messages just for you

To help make sure that you get the right messages to help you, you'll be asked to answer some questions about your medicines and what you think about them. Flo will then send you messages to help you get the most out of your medicines.

It's your choice!

If you are invited to join Flo by one of your pharmacy team, they will add a few details to Flo's system, including your mobile number. Flo will send you a message to your mobile phone introducing herself and asking you to confirm you want to join.

If you decide to join, you are giving your consent to share your information across the teams that help to to provide your care. Simply reply "YES" to get started.

If, for whatever reason, you decide that you want to stop using Flo, you simply need to send "STOP", and Flo will stop sending you messages.

The choice is yours!

IMPORTANT:
Florence is NOT an emergency service. If you feel unwell, contact your medical team in the usual way.

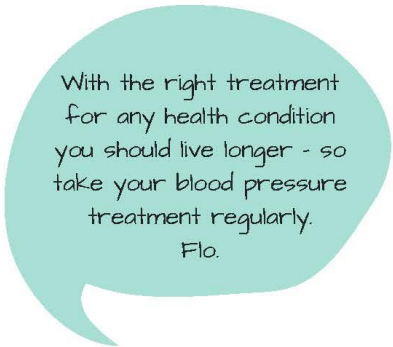
Sending messages to Flo

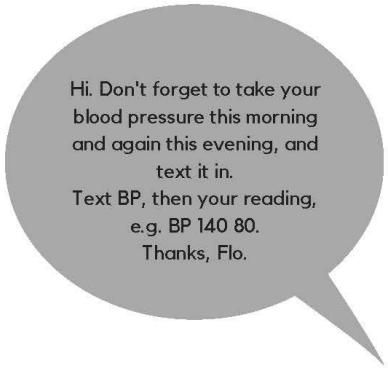
Flo can automatically record any readings you send her and can give you advice for you to act on if needed.

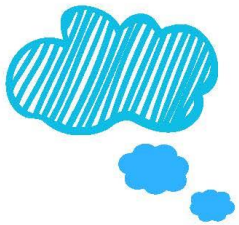
Flo is very flexible about how and when you send your readings in and Flo can be set up to expect your readings and messages at a time that suits you.

You can send them in before or after the scheduled time, its up to you. However, just to be helpful Flo may send you a reminder when your messages are due.

Types of messages from Flo







What do other people think about Flo?

"I was astonished at how Flo changed my medication habits."

"The service has altered my life. I feel supported...It's great."

Will Flo cost me anything?

You won't be charge for receiving messages from Flo. If you have a text message bundle in a phone contract, replying to Flo will use up one of your messages.

If you are on a pay as you go contract, it will cost you your standard network fee.

What about if I go on Holiday?

Flo can be used worldwide, but messages will be charged at your network rate outside of the UK. If you have a holiday planned, and you do not want to receive messages while you're away, just send Flo "AWAY". When you get back from your holiday simply send "HOME" to start receiving Flo's messages again.

Will Flo reply to my messages?

When you send a message to Flo, she will reply to you. Her reply will depend on what you send, and how your healthcare professional has set up what's right for you. Flo's reply will confirm if your what you've sent is what she's expecting for you, but if not she will give you some advice to follow.

All of Flo's messages are developed by your healthcare team following best practice, so you can be sure that the advice she gives you is safe to follow. If she asks you to contact someone, then make sure that you do.

What happens to the information I send to Flo?

Flo will save your readings to your profile on her system. This means that your pharmacist, doctor, nurse or other care specialist is able to check how you are doing.

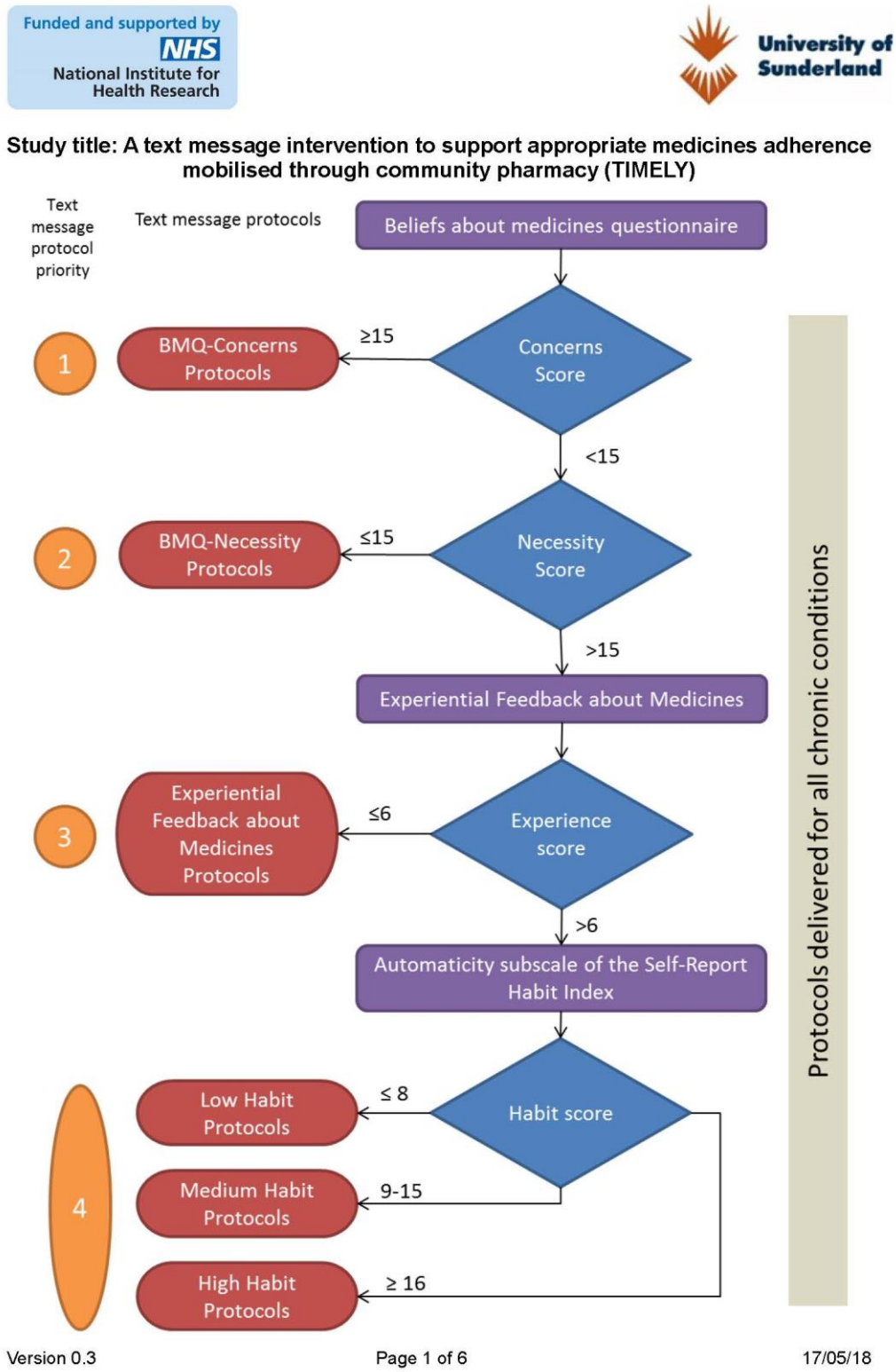
Being able to see your results will help your healthcare professional to provide the best ongoing care, informed by the up-to-date readings you send to Flo.

To start with, just the pharmacy will be able to see your readings.

What next?

If you think that Flo could help you, speak to your pharmacy and they can get you started.

Appendix 4 Principles for intervention personalisation prototype



Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Priority 1: Beliefs about Medicines Questionnaire- Concerns

Statement	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Having to take medicines worries me	5	4	3	2	1
I sometimes worry about the long-term effects of my medicines	5	4	3	2	1
My medicines disrupt my life	5	4	3	2	1
I sometimes worry about becoming too dependent on my medicines	5	4	3	2	1
My medicines are a mystery to me	5	4	3	2	1

Concern score

The extent to which the respondent is concerned about medication taking.

Protocol	BCT Name	Example TIMELY Text Message
BMQ-Concerns	Commitment	"Hi, it's Flo. Will you commit to taking your blood pressure medicines this week to reduce your risk of heart attacks and strokes? Reply Y for Yes or N for No"
BMQ-Concerns	Monitoring of emotional consequences	"Hi, it's Flo. How do you feel after you've taken your diabetes medication?"
BMQ-Concerns	Reduce negative emotions	"If you don't like the taste of your effervescent tablet, try mixing them with a bit of fruit juice. Take care, Flo"
BMQ-Concerns	Framing/ reframing	"Rather than seeing medicines as a reminder of your illness, think of them as a positive tool to keep you well."

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University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Priority 2: Beliefs about Medicines Questionnaire- Necessity

Statement	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
My health, at present, depends on my medicines	5	4	3	2	1
My life would be impossible without my medicines	5	4	3	2	1
Without my medicines I would be very ill	5	4	3	2	1
My medicines protect me from becoming worse	5	4	3	2	1
My health in the future will depend on my medicines	5	4	3	2	1

Necessity score

The extent to which the respondent believes that their medication is necessary.

Protocol	BCT Name	Example TIMELY Text Message
BMQ-Necessity	Information about health consequences	"By taking your statin tablet every day, you reduce cholesterol in your blood. This reduces the risk of clots which can cause heart attacks and strokes. Flo"
BMQ-Necessity	Salience of consequences	"Uncontrolled diabetes can damage the blood supply to your feet. This can lead to amputation. Take your medication to reduce the risk of amputation. Flo"
BMQ-Necessity	Information about social and environmental consequences	"Treating diabetes costs the NHS £9.8 billion. Taking your medication and staying well means the NHS doesn't need to spend as much money to look after you. Flo"
BMQ-Necessity	Credible source	"Your diabetes consultant has said that it is really important that you take your diabetes medication every day. Flo"

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University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Priority 3: Experiential feedback from medicines taking

Experiential feedback from medication questions (EFM)					
Statement	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I have noticed the positive benefits of taking my medication	5	4	3	2	1
I have experienced solid/ convincing evidence that my medication does what it is supposed to do	5	4	3	2	1

Experiential Feedback from Medicines Taking Score

The extent to which respondents believe that their medication is working for them.

Protocol	BCT Name	Example TIMELY Text Message
Experiential feedback about medicines	Goal setting (outcome)	"Great news, your blood pressure was within target every day last week! Keep going with taking your medication. Flo"
Experiential feedback about medicines	Review outcome goal(s)	"Hi, it's Flo. You wanted to keep your BP within your target for 4 weeks. You managed to keep in target for 3 weeks. How many weeks will you aim for this time?"
Experiential feedback about medicines	Self-monitoring of outcome(s) of behaviour	"Hi, it's Flo. Let's see how well your preventer is helping your asthma. Make a note of when you feel breathless and I'll text you at the end of the week."
Experiential feedback about medicines	Biofeedback	Blood pressure self-monitoring, blood glucose self-monitoring
Experiential feedback about medicines	Feedback on outcome(s) of behaviour	"Thanks for telling me about your asthma symptoms. Your ACT score is 3, this means that your asthma is well controlled. Take care, Flo"
Experiential feedback about medicines	Behavioural experiments	"Hi, it's Flo. If you're not convinced that your medication works, why not stop taking it for a week and see what happens."

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University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Priority 4: Habit formation for Medicines Taking

Automaticity subscale of the Self-Report Habit Index (A-SRHI)					
Statement	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Medication-taking is something that I do automatically	5	4	3	2	1
I take my medicines without having to consciously remember	5	4	3	2	1
Medication-taking is something that I do without thinking	5	4	3	2	1
I start taking my medication before I realise I'm doing it	5	4	3	2	1

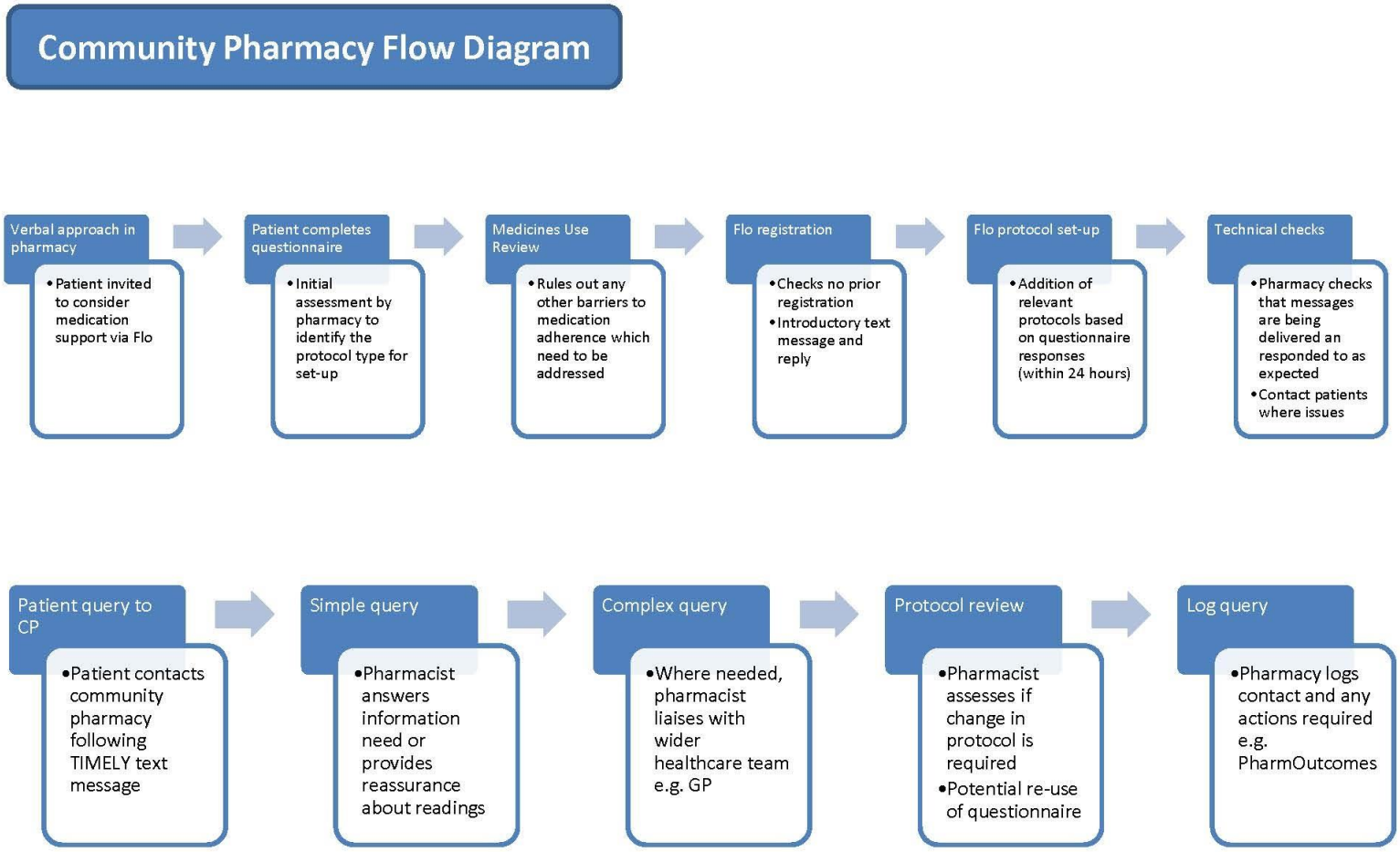
Medication Taking as a Habit Score

The extent to which medicines taking has become a habit.

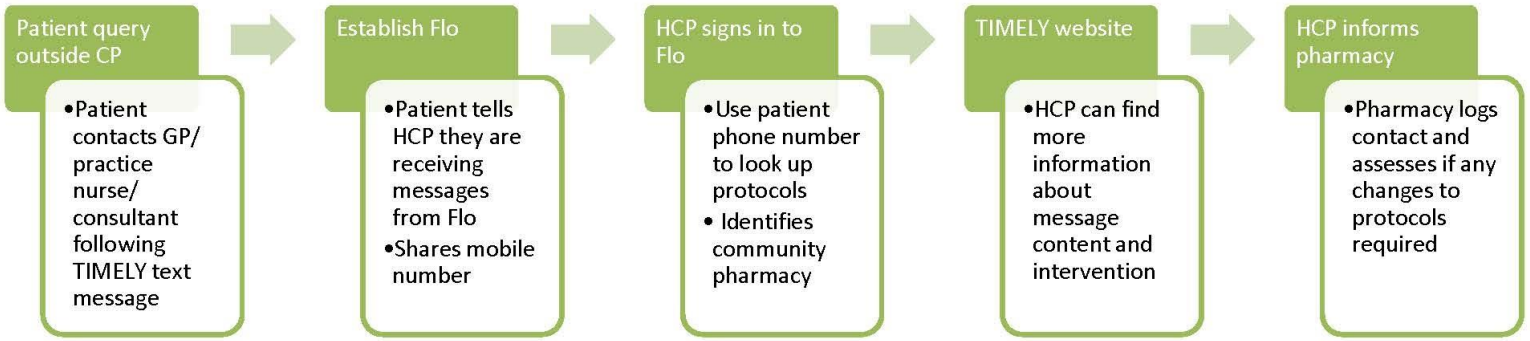
Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Protocol	BCT Name	Example TIMELY Text Message
Low Habit	Monitoring of behaviour by others without feedback	"Hi, it's Flo. Were you able to take your diabetes medication this morning? Text MEDS followed by the number of tablets you took this morning"
Low Habit	Goal setting (behaviour)	"Hi, it's Flo. How many days this week would are you planning to take your medication 100% correctly?"
Low Habit	Review behaviour goal(s)	"Hi, it's Flo. Last week you wanted to take at least 6 of your statin tablets. You managed you taken them 4 times. How many times will you aim for this week?"
Low Habit	Discrepancy between current behaviour and goal	"Hi, it's Flo. Last week you wanted to take at least 6 of your statin tablets. You managed you taken them 4 times. How many times will you aim for this week?"
Low Habit	Feedback on behaviour	"You managed to take your preventer inhaler every day last week. Florence"
Low Habit	Prompts/cues	"Hi, it's Flo. Just a reminder that it's time to take your medication."
Low Habit	Social reward	"Hi, it's Flo. You're doing great with your medication taking - well done!"
Medium Habit	Monitoring of behaviour by others without feedback	"Hi, it's Flo. How many days this week would you say you missed one of your medications? Text DAYS followed by the number. Thanks."
Medium Habit	Self-monitoring of behaviour	"I'd love to know how many doses of your preventer inhaler you managed this week. Make a note of when you take it, and I'll text you at the end of the week. Flo"
Medium Habit	Behavioural practice/ rehearsal	"Hi, it's Flo. It's 8am so you should be in the kitchen taking your blood pressure medicine before you've had your breakfast."
Medium Habit	Habit formation	"Try taking your medication at the same time and in the same place each day. This will help you develop the habit of taking your medicines. Flo"
Medium Habit	Adding objects to the environment	"Try putting a sticker in the place where you normally take your medicines, seeing the sticker will remind you to take your medicines. Flo"
High Habit	Monitoring of behaviour by others without feedback	"Hi, it's Flo. Can you let me know what the count is on your inhaler? Text COUNT followed by the number. Thanks."

Appendix 5 Flow diagram of integration pathway prototype



Wider Healthcare Team Flow Diagram



Appendix 6 Patient invitation letter for the co-design of intervention concept study

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Department of Pharmacy and Pharmaceutical Sciences
Faculty of Health Sciences and Wellbeing
University of Sunderland
Dale Building
Sciences Complex
Wharncliffe Street
Sunderland
SR1 3SD

17th September 2018

Dear PCPI Member,

WE WOULD LIKE TO ASK FOR YOUR HELP

We would like to invite you to take part in a research study called the TIMELY study which is being done at the University of Sunderland. It aims to explore what patients who take medicine(s) for long term conditions, think about using text messages to help them. We know that a lot of people can struggle to take the right medicine, at the right time, in the right way, and we think that text messages personalised to them and their medicines might help. We're using a system called Florence made by Simple Telehealth which is already being used in the NHS, to deliver the new service.

Taking part involves coming along to a group discussion with other patients who take medicines for a long term condition. We have already organised these to take place on two dates (see below) and you can come along to either date. You would only need to attend one of these groups.

If you would like to take part in this study or want to know more about it, please read the information sheet which comes with this letter.

The group discussions are:

Option 1
Thursday 11th October 2018 2.30pm to 4pm

Taking place at the University of Sunderland in **Pasteur 171** at the **City Campus**.
The post code for the building is **SR1 3SD**.

Option 2
Thursday 1st November 2018 9.30am to 11am

Taking place at the University of Sunderland in **Pasteur 171** at the **City Campus**.
The post code for the building is **SR1 3SD.**

Kind regards,

Gemma Donovan
On behalf of the TIMELY team

Appendix 7 Participant information sheet for patients used in the co-design of intervention concept study

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Information Sheet for Patient Participants

Study title
The study is called TIMELY which stands for a 'text message intervention to support appropriate medicines adherence mobilised through community pharmacy'.

Why is TIMELY being carried out?
We want to find out what patients and others think about using text messages to help people to take the right medicines, at the right dose, at the right time and in the right way. We know that a lot of people struggle to do this every day, and we think text messages, personalised to the person and their medicines, might help. We're looking at a system called 'Florence' which has already been created by an organisation called Simple Telehealth. The system is already being used to send and receive text messages from patients. We've started to think about the text messages might say for this new service, and how it might be delivered from a community pharmacy, but we'd like to ask other people what they think about our ideas so far.

Why have I been asked to take part?
You have told us that you're currently taking a medicine for a long term condition. You are the exactly the type of person we are hoping that our text messages can help, so it's really important to find out what you think.

What would I have to do?
We would like you to come along to a group meeting with other people who also take a medicine for a long term condition. We want to show you the ideas that we've had so far and ask everyone what they think about them. The ideas that will be presented include:

- A video showing how the pharmacist might introduce patients to the text message service
- A questionnaire that has been designed to personalise the text message to what patients might want to help them
- An information leaflet that has been designed to introduce the text message service to patients

We think this will last about between 1 hour and 1½ hours. We will record it all using a voice recorder so that we make sure that we have an accurate record of the feedback we receive from patients to make changes to the ideas that we've had. We'll also collect in any written notes that you make on the day, to make sure that we don't miss anything.

After the group meeting, we're going to summarise all of the ideas that everyone came up with. We'd then like to send you this summary and ask you to tell us which changes you think are the most important. This can be done either by email or post, whichever you prefer.

How will my information be kept confidential?
We won't use your name on anything we write. We might use some of your words in our reports, but we won't say that it was you who said it. We will only keep your name and information about you in very safe places and separated from the recordings. If you are worried about that we can tell you more about it.

Will I be able to get my money back if I have to travel to take part?
Yes. We don't want taking part in the study to cost you anything. This means that we will give you the money for any bus fares or other travel costs which you have to pay to take part.

Will I get paid for taking part?
No. But we will be giving everyone who takes part a £20 Love2Shop gift voucher as a 'thank you' for taking part in our project.

Are there any risks to me from taking part?
We don't think there will be any risks to you from taking part.

What is the study for?
The information we get from TIMELY will help us to make sure that our text message service is helpful for patients. Once we've made changes we plan to send patients these text messages for a short amount of time, and have more group discussions to find out what people thought. If you like,

you can work with us again on this next stage, and we'll provide you with the chance to express you interest in the next phase at the end of the group. However, you do not have to do this. You can just come along to this first group.

Will anyone else know that I've taken part?
No. The only people who will that you've taken part are the TIMELY study team and the other people who are in the group with you.

Do I have to take part and can I change my mind?
Taking part in the study is voluntary. Even if you return a form to us to say you are happy to take part, you can stop taking part at any time and you don't have to tell us why. Stopping taking part won't affect your relationship with the TIMELY team, the University of Sunderland, or your healthcare team. But we do need to tell you that once we've finished the study and written our reports, it will be too late to decide to stop taking part. So you need to let us know if you don't want to carry on as soon as possible.

Who can I contact if I have questions about the study?
If you have any questions, we would like you to get in touch with us. You can do this by telephoning Gemma Donovan (the researcher) on 0191 5152396 or on her mobile phone number on 07971 061447 or by email at Gemma.Donovan@sunderland.ac.uk

If you have any questions about your medicines, you should contact your normal doctor.

What will happen to the results of the research?
Once we have collected all of the information from the people who take part, we will want to let other people know what we have found. This might be through writing articles for journals, magazines or newspapers. We also might tell people about it at conferences. We hope that by telling people what we've found out, we can continue to explore how text messages might help people with their medicines. Don't worry though, if we use some of your words we will use a code or a different name, so nobody will be know what you said.

Who is doing the study?
The research is being done by a research team at the University of Sunderland. The Chief Investigator for the project is Gemma Donovan. She is a Doctoral Research Fellow in the School of Pharmacy and Pharmaceutical Sciences.

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Who is paying for TIMELY?
TIMELY is being supported by the research arm of the NHS, the National Institute of Health Research (NIHR) who have given us some money to carry out the study.

Have other patients and the public helped with the study?
Three members of the research team are patients and have helped us design this research and the information you're reading. They come along to all of our project meetings to make sure that what we're doing will be useful for patients in the future.

What happens to my data?
The University of Sunderland is the sponsor for this study based in the United Kingdom. We will be using information from you which you will provide in the consent form, focus group recording, and voting sheet, in order to undertake this study and will act as the data controller. This means that we are responsible for looking after your information and using it properly. The University of Sunderland will keep identifiable information about you until you have provided your voting choices, and then this data will be destroyed.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

You can find out more about how we use your information by contacting Gemma Donovan.

Has anyone checked that TIMELY is okay to do?
TIMELY has been reviewed and given what they call a 'favourable opinion' by an NHS Research Ethics Committee and it has also been approved by the University of Sunderland Research Ethics Committee. They are happy that TIMELY is okay to be carried out by the team, and that no harm will come to you or them.

If you're concerned and want to talk to someone independent of the TIMELY team, you can contact the Chair of the University of Sunderland Research Ethics Committee, Dr John Fulton, on john.fulton@sunderland.ac.uk or 0191 515 2529.

What should I do if I want to take part?
If you don't have any questions and would like to take part, please can you fill in the **CONSENT FORM** (enclosed) and send it to us in the pre-paid envelope. It will let us know the best way for us to get in touch with you. We don't know how many people will want to help us so we might find we have too many and we may not need to ask for your help.

Once we have your form, someone from the TIMELY team will get in touch with you to arrange which focus group you can attend. There are currently two options:

Option 1:

[DAY] [DATE] [MONTH] [YEAR] at [TIMES]

It will be taking place at the University of Sunderland in **[ROOM] [BUILDING] [CAMPUS]** The post code for the building is [POST CODE].

Appendix 8 Consent form for patient used in the co-design of intervention concept study

Funded and supported by NHS National Institute for Health Research

University of Sunderland

PATIENT PARTICIPANT CONSENT FORM FOR FOCUS GROUPS

We're so pleased that you have agreed to help us with TIMELY.

Let us know how you would like to be contacted by the TIMELY team by placing a cross **(X)** in one of the boxes below:

	Please cross (X) how you would like us to contact you
Calling on the telephone (we don't mind if this is on your landline or mobile phone)	
Text messaging	
E-mail	
Letter	

Please let us have the contact details for the way you want us to get in touch with you below

_____

_____

_____

Can you also please place a cross (X) in the box below to let us know that you have read our letter and information leaflet and are happy to take part.

	Please cross (X) in the box below
I have read the letter and information sheet about TIMELY and I am happy to take part and understand that I can stop taking part if I want to	

Welcome to the TIMELY study. Someone will be in touch to arrange to book you into one of our focus groups, in the way that you've asked us to.

Thank you very much for your time.

Please post this contact form back to us using the stamped and addressed envelope included with this letter. You can keep the original letter and information sheet for you to look at later if you want to.

Appendix 9 Invitation letter for healthcare professionals used in the co-design of intervention concept study

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Department of Pharmacy and Pharmaceutical Sciences
Faculty of Health Sciences and Wellbeing
University of Sunderland
Dale Building
Sciences Complex
Wharncliffe Street
Sunderland
SR1 3SD

17th September 2018

Dear Colleague,

WE WOULD LIKE TO ASK FOR YOUR HELP

We would like to invite you to take part in a research study called the TIMELY study which is being done at the University of Sunderland. It aims to explore what professionals who support patients taking medicines for long term conditions, think about using text messages to help them. We know that a lot of people can struggle to take the right medicine, at the right time, in the right way, and we think that text messages personalised to them and their medicines might help. We're using a system called Florence made by Simple Telehealth which is already being used in the NHS, to deliver the new service.

Taking part involves coming along to a group discussion with other healthcare professionals. We have already organised these to take place on two dates (see below) and you can come along to either date. You would only need to attend one of these groups.

If you would like to take part in this study or want to know more about it, please read the information sheet which comes with this letter.

The group discussions are:

Option 1
Tuesday 2nd October 2018 6.30pm- 8.00pm

Taking place at the Quality Hotel, Boldon. The post code for the building is NE35 9PE. A supper will be provided.

Option 2
Wednesday 14th November 2018 2pm – 3.30pm (November TITO)

Taking place at the Stadium of Light. The post code for the building is SR5 1SU. Lunch will be provided.

Kind regards,

Gemma Donovan
On behalf of the TIMELY team

Appendix 10 Participant information sheet for healthcare professionals used in the co-design of intervention concept study

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Information Sheet for Professional Participants

You have been invited to take part in a research study. Before you decide, we would like you to understand why the research is being done, and what it will involve for you. Please read this information sheet and feel free to contact the team of researchers for this project (contact details at the end of sheet) if you have any questions.

The purpose of the research
This research aims to discover the views of patients, prescribers and pharmacists about using text messages as a potential tool to support adherence to medicines. We're planning to use Simple Telehealth (Florence) as a platform for delivering the text message service. We have developed a number of materials to demonstrate what a new text message service for medication adherence might look like, and are looking for feedback in order to further improve the design.

Why have I been chosen to take part?
Any healthcare professional involved in supporting patients with their medicines can take part.

What will happen to me if I take part?
Taking part in this research involves taking part in a face-to-face focus group with other healthcare professionals. The materials that will be presented for feedback include:

- Examples of how an assessment questionnaire would link to text message content
- A video of the proposed consultation structure for the intervention
- A flow diagram of how the intervention might be delivered

We think this will last between 1 hour and 1½ hours. We will record it all so that we make sure that we have an accurate record of the feedback we receive to make changes to the materials that are presented. We'll also collect in any written notes that you make on the day, to make sure that we don't miss anything.

After the group meeting, we're going to summarise all of the ideas. We'd then like to send you this summary and ask you to tell us which changes you think are the most important. This can be done either by email or post, whichever you prefer.

Confidentiality and anonymity
All transcripts will be anonymised and your identity will not be revealed anywhere including in the reports of the research. Your data will be stored only on password protected computers and any paper based data will be stored in locked cupboards in locked offices. Only those conducting the study will have access to your personal data and it will not be shared with anyone else. However, it may be that appropriate members of the University of Sunderland may be given access to your data for monitoring or audit of this study to ensure we are complying with standards and regulations. What you say will not be able to be linked to your name.

What are the potential disadvantages or risks from taking part?
No disadvantages or risks have been identified to you from taking part.

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

What are the possible benefits of taking part?
There are no direct benefits to yourself from taking part, but you would be helping us to investigate a new approach to supporting adherence to medicines for patients and the NHS.

Right to refuse or withdraw
Participation in this research is voluntary. If you agree to take part, we will ask you to sign a consent form. Even if you sign this consent form, you are free to withdraw at any time, without giving a reason. This would not affect your relationship with either the researcher or the University of Sunderland. However, once the study is complete and the results have been published, there will not be an opportunity for you to withdraw your data.

Outcomes of the research
The information we get from this study will help improve our intervention, ready for another testing phase. This will deliver messages 'live' for a short period of time followed by further feedback in focus groups. There will be an option to an express and interest in the next phase of the research, but there is no commitment to this by taking part in this first phase.

Who is undertaking the research?
The research is being undertaken by a research team at the University of Sunderland. The Chief Investigator for the project is Gemma Donovan, Academic Practitioner in the Department of Pharmacy and Pharmaceutical Sciences at the University of Sunderland.

What happens to my data?
The University of Sunderland is the sponsor for this study based in the United Kingdom. We will be using information from you which you will provide in the consent form, focus group recording, and voting sheet, in order to undertake this study and will act as the data controller. This means that we are responsible for looking after your information and using it properly. The University of Sunderland will keep identifiable information about you until you have provided your voting choices, and then this data will be destroyed.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

You can find out more about how we use your information by contacting Gemma Donovan.

Expenses and payment
There are no payments available for participation.

Funding
The research is being supported by the National Institute of Health Research who have funded the project.

Approval
This study has been reviewed and given favourable opinion by NHS Research Ethics Committee and approved by the University of Sunderland Research Ethics Committee.

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Who can I talk to if I have more questions about the research?
If you have any questions, want more information about the study or if you have any concerns about the research, you can contact the research team. This can either by email on Gemma.Donovan@sunderland.ac.uk or by phone on 0191 5152396 or on 07971 061447 between Monday to Friday.

You can also contact the Chair of the University of Sunderland Research Ethics Committee, Dr John Fulton, on john.fulton@sunderland.ac.uk or 0191 515 2529.

What to do if you wish to take part
If you would like to take part, please complete and return the attached consent form. A member of the research team with then be in touch to arrange which focus group you can attend.

Thank you for taking the time to read this information sheet.
We look forward to hearing from you.

Appendix 11 Consent form for healthcare professional participants used in co-design of intervention concept study

Private and Confidential

Participant Ref: _____

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Professional Participant Consent Form

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

	Please **initial all** of the following six boxes
1. I confirm that I have read and understand the 'Participant Information Sheet' dated 29/06/18 (version 1.1) for the above study and have had the opportunity to ask questions.	
2. I understand that I will be asked take part in one focus group with other healthcare professionals which will be audio-recorded.	
3. I understand that the participation is voluntary and that I am free to withdraw at any time, without giving any reason, without any negative consequences.	
4. I understand that the information collected during the focus group will be made anonymous so as to not reveal my identity to anyone other than the research team.	
5. I understand that my words may be quoted anonymously in publications, reports, webpages and other research outputs.	
6. I agree to take part in the study.	

Name of participant (please print): _____

Please provide your contact details so that we are able to get in touch with you to arrange which focus group you are able to attend.

Email address: _____

Phone number: _____

Signature of participant: _____ Date: _____

Signature of researcher: _____ Date: _____

Appendix 12 Example data collection sheet for silent generation of ideas used in co-design of intervention concept study

Participant Ref: _____

Prototype: TIMELY Consultation
Silent generation of ideas

Please make a note of what you like

Please make a note of what you think should be changed

Appendix 13 Topic guide for patient focus groups as part of the co-design of intervention concept study

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Focus Group Topic Guide - Patients

The following guide outlines the key areas for exploration during the focus group.

Aims and objectives
The overall aim of this study is to obtain feedback on prototypes which have been created as part of a new text message intervention to support adherence to medicines, delivered by community pharmacies.

This will include:

- To explore the best way to approach potential patients to receive the intervention in a community pharmacy setting
- To gain feedback on the assessment tool intended to be used to personalise the intervention
- To gather healthcare professionals' views on the consultation structure for the intervention
- To discover potential issues associated with the process which has been designed to deliver the intervention

Introduction
Aim: To introduce the research and set the context for the proceeding discussion

- Introduce self and Nicky: University of Sunderland, TIMELY study, why I am here
- Introduce the study: what it is about, who it is funded by
- Talk through key points
    - We want you to give us feedback on parts of the TIMELY intervention which have been designed so far
    - You will be introduced to an aspect of the design – video or paperwork
    - We'll ask you to take a look at these and write down what you like and don't like about each of these
    - We'll then get you to share what you think and have a discussion
    - There are no right or wrong answers
    - The whole session will last between 60 and 90 minutes
    - If you need to leave at any time during the session, feel free to do so
    - You don't have to answer all of the questions if you don't want to
    - Participation is voluntary and participant can withdraw at any time
    - After the session, we will write up some of the ideas and ask you to vote on which ones you think are the most important. This will help us prioritise what we need to change before we re-test the design
- Confidentiality/ anonymity
    - In report writing, any quotes won't be identified as being you
- The focus group will be audio recorded and Nicky will be observing and taking some notes
    - The recording will be kept secure, only accessed by the four researchers working on the project, and will be kept for 10 years as per policy
- I've brought vouchers for participation with me, so I'll give those to you at the end of the session
- This piece of paper is just to help me remember what questions I want to ask you
- Does anyone have any questions?

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

1. Prototype 1: Approaching patients about receiving the TIMELY intervention

Aim: to discover the best way for the TIMELY intervention to be introduced to patients

Actions:

- Introduce the video – what it will show, what feedback we are looking for
- Play video prototype
- Silent generation of ideas
  - What did you think worked well about how the TIMELY intervention was introduced to the patient in the video?
  - What could be done differently that might make the approach better for the patient?
- Sharing of ideas
  - Is the pharmacy counter the right place?
  - Was the language used appropriate?
  - What should the reason be that the patient is approached in the first place e.g. medicines generally or something more specific
  - What would encourage the patient to find out more?

2. Prototype 2: Personalising the TIMELY intervention

Aim: to gain feedback on the assessment tool intended to be used to personalise the intervention

Actions:

- Introduce the questionnaire for competition – what its purpose is, what feedback we are looking for
- Ask the participants to complete the questionnaire for themselves
- Silent generation of ideas
  - What did you think about the questions included?
  - Would they help identify any problems you had with your medicines?
- Sharing of ideas
  - Were the questions easy to understand?
  - Were they easy to answer?
  - Did any of them feel repetitive?
  - Would you answer the questions differently for different medicines/ LTCs?
  - Would you feel comfortable returning the completed questionnaire back to the pharmacist?
  - Where would you want to complete the questionnaire – waiting area or consultation room?

Note for co-facilitator: how long it takes for participants to complete the questionnaire?

3. Prototype 3: Video of TIMELY consultation following completion of the assessment

Aim: To discover potential issues associated with the process which has been designed to deliver the intervention

Actions:

- Introduce the video – what it will show, what feedback we are looking for
- Play video prototype
- Silent generation of ideas

- What did you think worked well about how the TIMELY intervention was set-up with the patient in the video?
- What could be done differently that might make the consultation better for the patient?

- Sharing of ideas
  - Would you feel comfortable handing back the questionnaire before the consultation?
  - Was the language used appropriate?
  - Did it seem to have a logical structure?
  - Do you think the MUR makes sure that only patients who are appropriate to receive the TIMELY intervention would be included?
  - Do you think the patient would be ready to engage with the intervention once they left the consultation?

4. Prototype 4: Patient information leaflet for the TIMELY intervention

Aim: to ascertain what information patients want to know about the TIMELY intervention before deciding whether or not to receive the intervention

Actions:

- Introduce the leaflet for reading – what its purpose is, what feedback we are looking for,
- Ask the participants to read the leaflet for themselves, invite patients to write on leaflets as they read if they would like to
- Silent generation of ideas
  - What did you think about the information included?
  - What do you think could be improved about the presentation of the information?
- Sharing of ideas
  - Was the information easy to understand?
  - Did they have any unanswered questions after reading the leaflet? / Further information they wanted.
  - Was the layout logical? (Have sections separated for rearrangement if needed)

Note for co-facilitator: how long it takes for participants to read the leaflet?

Next steps

- Thank the participants
- Do they have any remaining questions about the research
- Reassurance around confidentiality and anonymity
- Provide with gift vouchers
- They will be contacted in around one month to be asked to vote for which issues that have been discussed today are the most important ones to address as part of the next version of the TIMELY intervention
- They will also be asked if they would like to be invited to the next phase of focus groups which are planned for Spring 2019 (they can choose not to participate nearer the time)

Appendix 14 Topic guide for focus groups with healthcare professionals as part of the co-design of intervention concept study

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Focus Group Topic Guide – Healthcare Professionals

The following guide outlines the key areas for exploration during the focus group.

Aims and objectives
The overall aim of this study is to obtain feedback on prototypes which have been created as part of a new text message intervention to support adherence to medicines, delivered by community pharmacies.

This will include:

- To explore the best way to approach potential patients to receive the intervention in a community pharmacy setting
- To gain feedback on the assessment tool intended to be used to personalise the intervention
- To gather healthcare professionals' views on the consultation structure for the intervention
- To discover potential issues associated with the process which has been designed to deliver the intervention

Introduction
Aim: To introduce the research and set the context for the proceeding discussion

- Introduce self and Nicky: University of Sunderland, TIMELY study, why I am here
- Introduce the study: what it is about, who it is funded by
- Talk through key points
    - We want you to give us feedback on parts of the TIMELY intervention which have been designed so far
    - You will be introduced to an aspect of the design – video or paperwork
    - We'll ask you to take a look at these and write down what you like and don't like about each of these
    - We'll then get you to share what you think and have a discussion
    - There are no right or wrong answers
    - The whole session will last between 60 and 90 minutes
    - If you need to leave at any time during the session, feel free to do so
    - You don't have to answer all of the questions if you don't want to
    - Participation is voluntary and participant can withdraw at any time
    - After the session, we will write up some of the ideas and ask you to vote on which ones you think are the most important. This will help us prioritise what we need to change before we re-test the design
- Confidentiality/ anonymity
    - In report writing, any quotes won't be identified as being you
- The focus group will be audio recorded and Nicky will be observing and taking some notes
    - The recording will be kept secure, only accessed by the four researchers working on the project, and will be kept for 10 years as per policy
- This piece of paper is just to help me remember what questions I want to ask you
- Does anyone have any questions?

- What do you think could be improved about the process?

- Sharing of ideas
  - How can pharmacists/ GPs best communicate about the support provided via the TIMELY intervention? Should GPs be automatically notified?
  - Would a website repository of information help, how might this be organised?
  - Do they have any concerns about things that might go wrong?
  - How might we deal with the incorrect protocols being set up by the pharmacist?

Next steps

- Thank the participants
- Do they have any remaining questions about the research
- Reassurance around confidentiality and anonymity
- They will be contacted in around one month to be asked to vote for which issues that have been discussed today are the most important ones to address as part of the next version of the TIMELY intervention
- They will also be asked if they would like to be invited to the next phase of focus groups which are planned for Spring 2019 (they can choose not to participate nearer the time)

Appendix 15 NHS Research Ethics Committee Approval Letter for co-design of TIMELY intervention concept study

Health Research Authority

London - Riverside Research Ethics Committee
Level 3 Block B
Whitefriars
Lewins Mead
Bristol
BS1 2NT

Telephone: 020 7104 8044

Please note: This is the favourable opinion of the REC only and does not allow you to start your study at NHS sites in England until you receive HRA Approval

29 June 2018

Ms Gemma Donovan
Academic Practitioner
University of Sunderland
Dale 113 Sciences Complex
Wharncliffe Street
Sunderland
SR1 3SD

Dear Ms Donovan

Study title:	**A Text message Intervention to support appropriate adherence to MEdicines from community pharmacY (TIMELY) - Prototyping study of the new intervention**
REC reference:	**18/LO/1201**
IRAS project ID:	**238875**

The Proportionate Review Sub-committee of the London - Riverside Research Ethics Committee reviewed the above application on 27 June 2018.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this favourable opinion letter. The expectation is that this information will be published for all studies that receive an ethical opinion but should you wish to provide a substitute contact point, wish to make a request to defer, or require further information, please contact hra.studyregistration@nhs.net outlining the reasons for your request. Under very limited circumstances (e.g. for student research which has received an unfavourable opinion), it may be possible to grant an exemption to the publication of the study.

Ethical opinion

On behalf of the Committee, the sub-committee gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Conditions of the favourable opinion

The REC favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements. Each NHS organisation must confirm through the signing of agreements and/or other documents that it has given permission for the research to proceed (except where explicitly specified otherwise).

Guidance on applying for HRA and HCRW Approval (England and Wales)/ NHS permission for research is available in the Integrated Research Application System, www.hra.nhs.uk or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of management permissions from host organisations.

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database. This should be before the first participant is recruited but no later than 6 weeks after recruitment of the first participant.

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g. when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non-clinical trials this is not currently mandatory.

If a sponsor wishes to request a deferral for study registration within the required timeframe, they should contact hra.studyregistration@nhs.net. The expectation is that all clinical trials will

be registered, however, in exceptional circumstances non registration may be permissible with prior agreement from the HRA. Guidance on where to register is provided on the HRA website.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Ethical review of research sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion").

Summary of discussion at the meeting

The PR Sub-Committee agreed that this was a well presented study with no material ethical issues.

Approved documents

The documents reviewed and approved were:

Document	*Version*	*Date*
Copies of advertisement materials for research participants [Advertisement to recruit patient participants]	1	17 May 2018
Covering letter on headed paper [REC Covering Letter]	1	29 May 2018
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [University of Sunderland Insurance]	N/A	29 June 2017
Interview schedules or topic guides for participants [Topic guide for focus group with patients]	1	17 May 2018
IRAS Application Form [IRAS_Form_18062018]		18 June 2018
IRAS Application Form XML file [IRAS_Form_18062018]		18 June 2018
IRAS Checklist XML [Checklist_18062018]		18 June 2018
Letter from funder [NIHR DRF Funding Letter]	N/A	24 August 2016
Letters of invitation to participant [Invitation letter for patients]	1	17 May 2018
Other [Consent form for professional participants]	1	17 May 2018
Other [PIS for professional participants]	1	17 May 2018
Other [Information sheet for professional participants]	1	17 May 2018
Participant consent form [Consent form for patients]	1	17 May 2018
Participant information sheet (PIS) [Patient PIS]	1	09 April 2018
Referee's report or other scientific critique report [NIHR DRF Funding Panel Report]	N/A	11 August 2016
Research protocol or project proposal [TIMELY Phase 1 Research Protocol]	1	29 May 2018
Summary CV for Chief Investigator (CI) [Gemma Donovan CV]	N/A	29 May 2018
Summary CV for student [Gemma Donovan CV]	N/A	29 May 2018
Summary CV for supervisor (student research) [Scott Wilkes CV]	N/A	29 May 2018
Summary CV for supervisor (student research) [TIMELY PH1 FG CV Felicity Smith]		

Summary CV for supervisor (student research) [TIMELY PH1 FG CV Jonathan Ling]		

Membership of the Proportionate Review Sub-Committee

The members of the Sub-Committee who took part in the review are listed on the attached sheet.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website:
http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/

HRA Training

We are pleased to welcome researchers and R&D staff at our training days – see details at http://www.hra.nhs.uk/hra-training/

With the Committee's best wishes for the success of this project.

18/LO/1201	**Please quote this number on all correspondence**

Yours sincerely

PP
Dr Matthew Hyde
Chair

Email: nrescommittee.london-riverside@nhs.net

Copy to: *Mr Martin Finlayson*
Ms Emma Murray, NIHR Clinical Research Network North East and North Cumbria

Appendix 16 Heath Research Authority Approval Letter for co-design of TIMELY intervention concept study

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

NHS
Health Research Authority

Ms Gemma Donovan
Academic Practitioner
University of Sunderland
Dale 113 Sciences Complex
Wharncliffe Street
Sunderland
SR1 3SD

Email: hra.approval@nhs.net
Research-permissions@wales.nhs.uk

29 June 2018

Dear Ms Donovan

HRA and Health and Care Research Wales (HCRW) Approval Letter

Study title:	**A Text message Intervention to support appropriate adherence to MEdicines from community pharmacY (TIMELY) - Prototyping study of the new intervention**
IRAS project ID:	**238875**
REC reference:	**18/LO/1201**
Sponsor	**University of Sunderland**

I am pleased to confirm that HRA and Health and Care Research Wales (HCRW) Approval has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

How should I continue to work with participating NHS organisations in England and Wales?
You should now provide a copy of this letter to all participating NHS organisations in England and Wales, as well as any documentation that has been updated as a result of the assessment.

Following the arranging of capacity and capability, participating NHS organisations should **formally confirm** their capacity and capability to undertake the study. How this will be confirmed is detailed in the "*summary of assessment*" section towards the end of this letter.

You should provide, if you have not already done so, detailed instructions to each organisation as to how you will notify them that research activities may commence at site following their confirmation of capacity and capability (e.g. provision by you of a 'green light' email, formal notification following a site initiation visit, activities may commence immediately following confirmation by participating organisation, etc.).

It is important that you involve both the research management function (e.g. R&D office) supporting each organisation and the local research team (where there is one) in setting up your study. Contact details of the research management function for each organisation can be accessed here.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?
HRA and HCRW Approval does not apply to NHS/HSC organisations within the devolved administrations of Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report (including this letter) has been sent to the coordinating centre of each participating nation. You should work with the relevant national coordinating functions to ensure any nation specific checks are complete, and with each site so that they are able to give management permission for the study to begin.

Please see IRAS Help for information on working with NHS/HSC organisations in Northern Ireland and Scotland.

How should I work with participating non-NHS organisations?
HRA and HCRW Approval does not apply to non-NHS organisations. You should work with your non-NHS organisations to obtain local agreement in accordance with their procedures.

What are my notification responsibilities during the study?
The document "*After Ethical Review – guidance for sponsors and investigators*", issued with your REC favourable opinion, gives detailed guidance on reporting expectations for studies, including:

- Registration of research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics, and is updated in the light of changes in reporting expectations or procedures.

I am a participating NHS organisation in England or Wales. What should I do once I receive this letter?
You should work with the applicant and sponsor to complete any outstanding arrangements so you are able to confirm capacity and capability in line with the information provided in this letter.

The sponsor contact for this application is as follows:

Name: Dr Martin Finlayson
Email: martin.finlayson@sunderland.ac.uk

Who should I contact for further information?
Please do not hesitate to contact me for assistance with this application. My contact details are below.

Your IRAS project ID is **238875**. Please quote this on all correspondence.

IRAS project ID	238875

Yours sincerely

Thomas Fairman
HRA Assessor

Email: hra.approval@nhs.net

Copy to: *Mr Martin Finlayson, Sunderland University, (Sponsor Contact)*
Ms Emma Murray, NIHR Clinical Research Network North East and North Cumbria, (Lead NHS R&D Contact)

Appendix 17 Ranking questionnaire for patients as part of the co-design of intervention concept study

TIMELY Phase 1 Patients FINAL

Start of Block: Introduction

Q2
Thank you for coming along to a focus group as part of the TIMELY study. Your feedback was extremely useful. As promised, this has now been analysed.

For this survey we want to get a clearer picture of what the most important points of feedback were. This includes:
Which parts of the design you most liked, and are important to keep Which changes to the design are the most important to make

This is the **patient** version of the questionnaire. For information: some of the feedback from the professional focus groups may have been added to the patient version of the questionnaire where appropriate. This means that you will see statements which did not come up in your own focus group, however I would encourage you to still consider these when answering the questions.

You will be asked to rank statements that you think are the most important for keeping parts of the TIMELY intervention, and things to change. This will be repeated for all the prototypes we looked at in the focus group. The questionnaire is organised as one page per prototype. As a reminder, the prototypes we looked at in your focus group were:
The approach to patients by the pharmacy assistant
The questionnaire The consultation with the pharmacist
The patient information leaflet

There are copies of the original prototypes available to help you with ranking the statements as well. I really appreciate you completing this last part of the research to help us with the next phase of the TIMELY study.

Thanks,
Gemma Donovan
On behalf of the TIMELY team

End of Block: Introduction

Start of Block: Prototype 1: Pharmacy approach

Q5 The following section relates to **Prototype 1: The approach to patients by the pharmacy assistant** at the pharmacy counter. You can watch the video again if you would like to here:

https://www.dropbox.com/s/4o51wzxr3qkhfka/TIMELY%20Patient%20Approach%20Prototype.mp4?dl=0

Q6 Please rank the **top five** parts of the design you **most liked** from 1 (most liked) to 5 (less liked) by typing the corresponding number in the box provided. Any statements that you don't rank will be considered least liked.
_____ Right information given to allow the patient to make a decision (1)
_____ The informal approach (2)
_____ That it was built on an existing relationship between the patient and the pharmacy assistant (3)
_____ No pressure was put on the patient to sign up (4)
_____ There was an open amount of time given to complete the questionnaire (5)
_____ The introduction was very general, not targeted at a specific patient based on a judgment of their previous compliance (6)

Q7 Please rank the **top five** most important things which you think need to be changed from 1 (most important to change) to 5 (less important to change) by typing the corresponding number in the box provided. Any statements that you don't rank will be considered least important.
_____ Patient should be offered the option to complete the questionnaire in the consultation room or at home and bring in later (1)
_____ Patient should be offered help to complete the questionnaire if they need it (2)
_____ There needs to be a way of offering the service to patients who may have medicines delivered or who are housebound (3)
_____ Communication should be at the same level (e.g. both sitting down or both standing) (4)
_____ The pharmacy assistant should ask the patient if they have a mobile phone before introducing them to the service (5)
_____ The patient information leaflet should be offered before the patient is asked to complete the questionnaire (6)
_____ Pharmacists should also offer the service if issues are identified as part of a medication review (7)

Q11 Are there any additional comments you would like to add to your ranking for this part of the design?

_____

_____

_____

_____

_____

End of Block: Prototype 1: Pharmacy approach

Start of Block: Prototype 2: Questionnaire

Q8 The following section relates to **Prototype 2: The questionnaire** to set up the text message intervention. You can see the questionnaire again if you would like to here:
TIMELY Personalisation Questionnaire

Q9 ${Q6/QuestionText}
_____ Easy to read and understand (1)
_____ Use of tick boxes for most of the questions (2)
_____ Clear layout (3)
_____ Questions didn't feel too intrusive (4)
_____ Felt that my responses would identify any problems to address (5)

Q10 ${Q7/QuestionText}
_____ Ask whether people would like information about text to voice functions available on their phone (1)
_____ Add in a space for the phone number to be given (2)
_____ Add in a question to ask about who looks after the phone contract (e.g. son / daughter) (3)
_____ Pharmacist completes long term conditions, liaising with the GP surgery instead of the patient completing this on the form (4)
_____ Ask whether medication reminders is something the patient would benefit from (5)
_____ Add a question asking if the patient has regular carers (6)
_____ Add an additional statement in the questionnaire about medicines taking routine (e.g. I have a routine for taking my medicines) (7)
_____ Remove 'neither agree nor disagree' option in the questionnaire responses so that people have to answer positively or negatively (8)

Q12 Are there any additional comments you would like to add to your ranking for this part of the design?

_____

_____

_____

_____

_____

End of Block: Prototype 2: Questionnaire

Start of Block: Prototype 3: Consultation

Q14 The following section relates to **Prototype 3: The consultation with the pharmacist** to set up the text message intervention. You can watch the video we used in the focus group here: https://www.dropbox.com/s/s7ku6aq1zlruwpt/TIMELY%20Consultation%20Prototype.mp4?dl=0

Q15 ${Q6/QuestionText}
_____ Including a medication review as part of the set-up (1)
_____ Use of home monitoring equipment and sending in readings (2)
_____ Setting up the service with a message in the consultation (3)
_____ The use of Flo as a persona to communicate with (4)
_____ Taking place in a private consultation room (5)
_____ A clear explanation of the service being offered (6)
_____ Explanation about the costs of participating to the patient (7)
_____ Using a face-to-face method of communication (8)
_____ The opportunity to address medication adherence problems not covered by text messages (9)
_____ Providing a patient information leaflet (10)
_____ Ability of patients to choose the times messages were sent (11)
_____ Clear communication that the patient can opt-out of receiving at any time (12)
_____ Checking if the patient is experiencing any side effects from medication (13)

Q13 ${Q7/QuestionText}
_____ Make sure that timing of medication taking is captured and checked (1)
_____ Option for consultation to be done in patients' home (2)
_____ Add in verbal instructions on how to cancel text messages (3)
_____ Confirm long term conditions as part of the consultation (4)
_____ Provide an estimation of how many text messages the patient is likely to receive (5)
_____ Add a question to assess adherence (e.g. how many doses have you missed in the last 7 days) (6)
_____ Include a verbal explanation that Flo isn't a real person (7)
_____ Add in a more formal written consent process (e.g. sign a consent form) (8)
_____ Cover data protection and regulation in the verbal consent process (9)
_____ Ensure that home blood pressure monitoring equipment is accurate (calibrated) prior to use (10)
_____ Check patient knows how to correctly use peak-flow meter in consultation (11)
_____ Talk about the expected benefits of using text messages to support medicines taking (12)

Q16 Are there any additional comments you would like to add to your ranking for this element of the design?

_____

_____

End of Block: Prototype 3: Consultation

Start of Block: Prototype 4: Patient information leaflet

Q18 The following section relates to **Prototype 4: The patient information leaflet**. You can see a copy of the leaflet we used in the focus group again here:
TIMELY Patient Information Leaflet

Q19 ${Q6/QuestionText}
_____ Easy to read and understand (1)
_____ Covered most of the information the patient would need (2)
_____ Real examples of text messages the patient might receive (3)
_____ Comments from other people who have used the service (4)
_____ Clear layout (5)

Q20 ${Q7/QuestionText}
_____ Add space for a pharmacy stamp with name and contact details (1)
_____ Add in information about NHS 111 (2)
_____ Include more general message examples (e.g. not specific to high blood pressure) (3)
_____ Use real photos rather than graphics (e.g. ClipArt) (4)
_____ Add information on how long it will take Flo to respond (5)
_____ Include information on what happens if patient uses a error (e.g. typo) in the message (6)
_____ Make emergency information more prominent (7)
_____ Change references to "SMS" to "text message" (8)
_____ Change "Flo says hello" to something more formal (9)

Q21 Are there any additional comments you would like to add to your ranking for this part of the design?

_____

_____

_____

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_____

End of Block: Prototype 4: Patient information leaflet

Appendix 18 Ranking questionnaire for professionals used in the co-design of intervention concept study

TIMELY Phase 1 Professionals

Start of Block: Introduction

Q2 Thank you for coming along to a focus group as part of the TIMELY study. Your feedback was extremely useful. As promised, this has now been analysed.

For this survey we want to get a clearer picture of what the most important points of feedback were. This includes: Which parts of the design you most liked, and are important to keep
Which changes to the design are the most important to make

This is the **healthcare professional** version of the questionnaire. For information: some of the feedback from the patient focus groups may have been added to the professional version of the questionnaire where appropriate. This means that you will see statements which did not come up in your own focus group, however I would encourage you to still consider these when answering the questions.

You will be asked to rank statements that you think are the most important for keeping parts of the TIMELY intervention, and things to change. This will be repeated for all the prototypes we looked at in the focus group. The questionnaire is organised as one page per prototype. As a reminder, the prototypes we looked at in your focus group were:
The organisation and types of messages The pharmacist consultation The integration pathway
There are copies of the original prototypes available to help you with ranking the statements as well. I really appreciate you completing this last part of the research to help us with the next phase of the TIMELY study.

Thanks,
Gemma Donovan
On behalf of the TIMELY team

End of Block: Introduction

Start of Block: Prototype 1: The organisation and types of messages

Q5 The following section relates to **Prototype 1: The organisation and types of messages** to include in the intervention. You can see a copy of the prototype we used in the focus group here:
Intervention messages and organisation

Q6 Please rank the **top five** parts of the design from the statements below that you **most liked** from 1 (most liked) to 5 (less liked) by typing the corresponding number in the box provided. Those statements not ranked will be considered least liked.
_____ Two way communication between the patient and Flo (1)
_____ The inclusion of prompts / cues to support medicines taking (2)
_____ That the intervention is automated (3)
_____ The patient self-care emphasis which encourages patients to take responsibility (4)
_____ Messages tailored to patients' beliefs about medication (5)
_____ Messages encouraging patients to get feedback on medicines taking (e.g. blood pressure) (6)
_____ The simple language used in the messages (7)
_____ Prioritisation of concerns, then necessity, then experience, then habit. (8)
_____ The use of habit as a model for the messages (9)
_____ Realistic targets which allow 'imperfect' adherence (10)
_____ Providing information in smaller 'chunks' which may be easier for the patient to digest (11)
_____ The tailoring of content to individual patients (12)

Q7 Please rank the **top five** parts of the design from the statements below that you think need to be changed from 1 (most important to change) to 5 (less important to change) by typing the corresponding number in the box provided. Those statements not ranked will be considered least need to be changed.

_____ Create layers of messages, with more dramatic messages (e.g. amputation being reserved for those with persistent non-adherence) (1)

_____ Re-word the behaviour experimentation message to seek approval from a healthcare professional before stopping medication to notice any impact (2)

_____ Remove 'neither agree nor disagree' option in the questionnaire responses so that people have to answer positively or negatively (3)

_____ Add an additional statement in the questionnaire about medicines taking routine (e.g. I have a routine for taking my medicines) (5)

_____ Remove requirement to input keywords in responses such as "MEDS" or "DAYS" (6)

_____ Add in side-effect monitoring as part of the intervention (7)

_____ Provide home monitoring devices (e.g. blood pressure monitor where messages are indicated but patients do not have the equipment) (8)

Q11 Are there any additional comments you would like to add to your ranking for this element of the design?

_____

_____

_____

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_____

End of Block: Prototype 1: The organisation and types of messages

Start of Block: Prototype 2: Consultation

Q8 The following section relates to **Prototype 2: The pharmacist consultation** to set up the text message intervention. You can watch the video prototype we used in the focus group here: https://www.dropbox.com/s/s7ku6aq1zlruwpt/TIMELY%20Consultation%20Prototype.mp4?dl=0

Q9 ${Q6/QuestionText}
_____ Ability of patients to choose the times messages were sent (1)
_____ A clear explanation of the service being offered (2)
_____ The opportunity to address adherence problems not covered by text messages (3)
_____ Use of home monitoring equipment and sending in readings (4)
_____ Clear communication that the patient can opt-out of receiving messages at any time (5)
_____ Checking if the patient is experiencing any side effects from medication (6)
_____ Including a medication review as part of the set-up (7)
_____ Using a face-to-face method of communication (8)
_____ Providing a patient information leaflet (9)
_____ Setting up the service with a message in the consultation (10)
_____ Explanation about the costs of participating to the patient (11)
_____ The use of Flo as a persona to communicate with (12)
_____ Taking place in a private consultation room (13)

Q10 ${Q7/QuestionText}
_____ Add a question to assess adherence (e.g. how many doses have you missed in the last 7 days) (1)
_____ Include a verbal explanation that Flo isn't a real person (2)
_____ Add in a more formal written consent process (e.g. sign a consent form) (3)
_____ Cover data protection and regulation in the verbal consent process (4)
_____ Ensure that home blood pressure monitoring equipment is accurate (calibrated) prior to use (5)
_____ Check patient knows how to correctly use home monitoring equipment in the consultation before use (e.g. peak flow meter) (6)
_____ Talk about the expected benefits of using text messages to support medicines taking (7)
_____ Make sure that timing of medication taking is captured and checked (8)
_____ Option for consultation to be done in patients' home (9)
_____ Add in verbal instructions on how to cancel text messages (10)
_____ Confirm long term conditions as part of the consultation (11)
_____ Provide an estimation of how many text messages the patient is likely to receive (12)

Q12 Are there any additional comments you would like to add to your ranking for this element of the design?

_____

_____

_____

_____

_____

End of Block: Prototype 2: Consultation

Start of Block: Prototype 3: Integration Diagram

Q14 The following section relates to **Prototype 3: The integration pathway** to set up the text message intervention. You can see the flow diagram prototype we used in the focus group here: Flow diagram prototype v0.2

Q15 ${Q6/QuestionText}
_____ Community pharmacy led service (1)
_____ That data is accessible to all healthcare professionals (2)
_____ Makes good use of pharmacy support staff (3)
_____ Process is clear and makes sense (4)
_____ Use of PharmOutcomes (a software platform for community pharmacy teams) (5)
_____ A website can act as a portal for more detailed information about specific content where needed (6)

Q13 ${Q7/QuestionText}

_____ The nominated pharmacy should be the only one able to provide the service (1)

_____ General practice should receive notification of set-up for information only (2)

_____ Community pharmacies should contact the GP practice on behalf of patients initially where queries arise (3)

_____ Add in a message to ask if the patient is happy with the messages so far shortly after initiation of intervention (4)

_____ Messages should only be sent Monday - Thursday to allow quick access to healthcare professionals where there are queries (5)

_____ Confirm individual monitoring targets for patients with GP practice prior to using home monitoring (e.g. blood pressure targets for patients using home blood pressure monitoring) (6)

_____ GP practices should add notification of patient using Flo to GP record, to ensure any medication changes are communicated to the pharmacy (7)

_____ Notification to practices should include which protocols have been set up for patients. (8)

Q16 Are there any additional comments you would like to add to your ranking for this element of the design?

_____

_____

_____

_____

_____

End of Block: Prototype 3: Integration Diagram

Appendix 19 Email invitation text for patient participants to complete ranking questionnaire as part of co-design of intervention concept study

I hope this email finds you well. I'm just following up from the focus group you attended back in November. We're a bit later in getting back to you because we ended up running an extra focus group with GPs which wasn't set up until January so apologies for that. However, as promised the data from all the focus groups has now been analysed and we've put all the feedback together to form a questionnaire exercise, where we want you to tell us how important each of the parts of the design were for you.

You can find your individual link here [URL Link]:

This link is unique to you, so please don't forward it on to anyone else. If you would prefer a paper version of the questionnaire, please let me know and I can post one out to you.

If possible, I would ask that you complete the questionnaire by **Wednesday 6th March 2019**. If it looks like you haven't got to it yet, I'll send you an email the week before as a reminder. I would really appreciate it if you could complete this last exercise as part of the Phase 1 study.

If you have any questions, feel free to email me or ring. The best phone number to get me on is my mobile number on 07971 061447

Kind regards,
Gemma

Appendix 20 Email invitation text for healthcare professional participants to complete ranking questionnaire as part of co-design of intervention concept study

I hope this email finds you well. This it to follow up with the ranking questionnaire exercise I mentioned at the end of the focus group you attended for my research study back in October. Apologies that this has come later than expected. The study didn't manage to initially recruit GPs, so we had to run a 5th focus group which didn't get set up until January, hence this coming out a bit later than expected.

However, as promised the feedback from the focus groups has now been pulled together and we're asking everyone who took part to complete a short questionnaire asking them to rank the feedback to help us identify which points are most important to help us with the next version of the design.

Your **individual** questionnaire link can be found here:

This link is unique to you, so please don't forward it on to anyone else. If you would prefer a paper version of the questionnaire, please let me know and I can post one out to you.

If possible, I would ask that you complete the questionnaire by **Wednesday 6th March 2019**. If it looks like you haven't got to it yet, I'll send you an email the week before as a reminder. I would really appreciate it if you could complete this last exercise as part of the Phase 1 study.

If you have any questions, feel free to email me or ring. The best phone number to get me on is my mobile number on 07971 061447

Kind regards,
Gemma

Appendix 21 Invitation letter for co-design of intervention delivery with patients study

Funded and supported by NHS National Institute for Health Research

University of Sunderland

School of Pharmacy and Pharmaceutical Sciences
Faculty of Health Sciences and Wellbeing
University of Sunderland
Dale Building
Sciences Complex
Wharncliffe Street
Sunderland
SR1 3SD

18th November 2019

Dear PCPI Member,

CAN YOU HELP US WITH OUR RESEARCH STUDY ABOUT USING TEXT MESSAGES TO SUPPORT MEDICINE TAKING?

We would like to invite you to take part in a research study called the TIMELY study which is being done at the University of Sunderland. It aims to explore what patients who take medicine(s) for long term conditions, think about using text messages to help them. We know that a lot of people can struggle to take the right medicine, at the right time, and we think that text messages personalised to them and their medicines might help. We're using a system made by Simple Telehealth to deliver the new service.

Taking part involves receiving the intervention in a simulated environment. This includes:

- having a medicines review with a pharmacist (this is something that you might have received from your own community pharmacist)
- completing a questionnaire to help tailor the text messages to you and your long term conditions
- Receiving text messages for two weeks (the number of these will be determined by the questionnaire)

To get feedback on this new intervention, we'll ask you to keep a diary of your thoughts on the text messages and also participate in an interview (about 30 minutes) about your experience of this new intervention.

The study is based at the University of Sunderland City Campus, and the dates and times of the review and the interview can be arranged to accommodate your availability.

If you would like to take part in this study or want to know more about it, please read the information sheet which comes with this letter.

Kind regards,

Gemma Donovan
On behalf of the TIMELY team

Appendix 22 Participant information sheet for co-design of intervention delivery with patients study

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Information Sheet for Patient Participants

Study title
The study is called TIMELY which stands for a 'text message intervention to support appropriate medicines adherence mobilised through community pharmacy'.

Why is TIMELY being carried out?
We want to find out what patients and others think about using text messages to help people to take the right medicines, at the right dose, at the right time and in the right way. We know that a lot of people struggle to do this every day, and we think text messages, personalised to the person and their medicines, might help. We're using a system made by an organisation called Simple Telehealth. A similar system is already being used to send and receive text messages from patients in the NHS, and we're using a newer and more advanced version of this which is currently being used in the United States and New Zealand. We've already asked some patients about what they think about the design, and have now created an updated version based on their feedback which we'll like to test.

Why have I been asked to take part?
We would like people who have at least one of eight long term conditions included in our intervention (see below) and who own a mobile phone capable of sending and receiving text messages (SMS). It doesn't need to be a smart phone. The long-term conditions we are looking for people with are:

- Type 2 Diabetes (controlled with medication)
- High blood pressure
- Angina
- Heart failure
- Chronic obstructive pulmonary disorder (COPD)
- Asthma
- Chronic pain
- Depression

You can have other long-term conditions not on this list, as long as you have at least one of these.

What would I have to do?
The first step will be to invite you to have a medication review with a pharmacist. This is the first part of the intervention to make sure that there are no problems before starting to receive the text messages. You'll also be asked to fill in a questionnaire about what you think about your medicines.

After the medication review, we will set you up to receive text messages about your medicines for two weeks. Some of these text messages might be one-way and some might ask for a reply. We also might ask you to take some measurements to monitor your health and send in the readings.

We'll give you a diary so that if you have any thoughts about the messages you receive you can keep a note of these. Once you have received messages for two weeks, we will ask you to take part in a short interview where we will ask you questions about what you thought. This interview will last around 30 minutes. The interview will be recorded using a voice recorder so that we don't miss anything out.

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

How will my information be kept confidential?
We won't use your name on anything we write. We might use some of your words in our reports, but we won't say that it was you who said it. We will only keep your name and information about you in very safe places. Any text messages that you reply to are kept on secure computers that the University have evaluated to be safe. If you are worried about that we can tell you more about it.

Will I be able to get my money back if I have to travel to take part?
Yes. We don't want taking part in the study to cost you anything. This means that we will give you the money for any bus fares or other travel costs which you have to pay to take part. We can also provide you with a top-up voucher for your mobile phone if you need one.

Will I get paid for taking part?
No. But we will be giving everyone who takes part a £20 Love2Shop gift voucher as a 'thank you' for taking part in our project.

Are there any risks to me from taking part?
We don't think there will be any risks to you from taking part.

What is the study for?
The information we get from TIMELY will help us to make sure that our text message service is helpful for patients. We have already asked some patients about what they thought about our original design and have made some changes based on their suggestions. We can also make changes based on your feedback at this stage, ready for testing this in patients in the NHS.

Will anyone else know that I've taken part?
No. The only people who will that you've taken part are the TIMELY study team.

Do I have to take part and can I change my mind?
Taking part in the study is voluntary. Even if you return a form to us to say you are happy to take part, you can stop taking part at any time and you don't have to tell us why. Withdrawing from the study won't affect your relationship with the TIMELY team, the University of Sunderland, or your healthcare team. But we do need to tell you that once we've finished the study and written our reports, it will be too late to decide to stop taking part. So you need to let us know if you don't want to carry on as soon as possible.

Who can I contact if I have questions about the study?
If you have any questions, we would like you to get in touch with us. You can do this by telephoning Gemma Donovan (the researcher) on 0191 5152396 or on her mobile phone number on 07971 061447 or by email at Gemma.Donovan@sunderland.ac.uk If you have any questions about your medicines, you should contact your normal doctor.

What will happen to the results of the research?
Once we have collected all of the information from the people who take part, we will want to let other people know what we have found. This might be through writing articles for journals, magazines or newspapers. We also might tell people about it at conferences. We hope that by telling people what we've found out, we can continue to explore how text messages might help people with their medicines. Don't worry though, if we use some of your words we will use a code or a different name, so nobody will be know what you said.

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Who is doing the study?
The research is being done by a research team at the University of Sunderland. The Chief Investigator for the project is Gemma Donovan. She is a Doctoral Research Fellow in the School of Pharmacy and Pharmaceutical Sciences.

Who is paying for TIMELY?
TIMELY is being supported by the research arm of the NHS, the National Institute of Health Research (NIHR) who have given us some money to carry out the study.

Have other patients and the public helped with the study?
Three members of the research team are patients and have helped us design this research and the information you're reading. They come along to all of our project meetings to make sure that what we're doing will be useful for patients in the future.

What happens to my data?
The University of Sunderland is the sponsor for this study based in the United Kingdom. We will be using information from you which you will provide in the consent form, questionnaire, diary, interview and reply text messages in order to undertake this study and will act as the data controller. This means that we are responsible for looking after your information and using it properly. The University of Sunderland will keep identifiable information about you until you have provided your voting choices, and then this data will be destroyed.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible. You can find out more about how we use your information by contacting Gemma Donovan.

Has anyone checked that TIMELY is okay to do?
TIMELY has been reviewed and been approved by the University of Sunderland Research Ethics Committee. They are happy that TIMELY is okay to be carried out by the team, and that no harm will come to you or them.

If you're concerned and want to talk to someone independent of the TIMELY team, you can contact the Chair of the University of Sunderland Research Ethics Committee, Dr John Fulton, on john.fulton@sunderland.ac.uk or 0191 515 2529.

What should I do if I want to take part?
If you don't have any questions and would like to take part, please can you fill in the **CONSENT FORM** (enclosed) and send it to us by email. It will let us know the best way for us to get in touch with you.

Once we have your form, someone from the TIMELY team will get in touch with you to arrange the medication review.

Thank you for taking the time to read this information sheet.
We look forward to hearing from you.

Appendix 23 Participant consent form for co-design of intervention delivery with patient concept study

Funded and supported by NHS National Institute for Health Research

University of Sunderland

PATIENT PARTICIPANT CONSENT FORM

We're so pleased that you have agreed to help us with TIMELY.

Your full name: _____

Let us know how you would like to be contacted by the TIMELY team by placing a cross **(X)** in one of the boxes below.

	Please cross (X) how you would like us to contact you
Calling on the telephone (we don't mind if this is on your landline or mobile phone)	
Text messaging	
E-mail	
Letter	

Please let us have the contact details for the way you want us to get in touch with you below

_____

_____

Can you also please place a cross (X) in the box below to let us know that you have read our letter and information leaflet and are happy to take part.

	Please cross (X) in the box below
I have read the letter and information sheet about TIMELY and I am happy to take part and understand that I can stop taking part if I want to	

Welcome to the TIMELY study! Someone will be in touch to arrange to book you into a medication review, in the way that you've asked us to.

Please email this form to Gemma.Donovan@sunderland.ac.uk or post this contact form back to us using the stamped and addressed envelope included with this letter. You can keep the original letter and information sheet for you to look at later if you want to.

Appendix 24 Extract of participant diary for co-design of intervention delivery with patients

Thank you for taking part in the TIMELY Study. Please start this diary by recording your thoughts about the medication review you received from the pharmacist. In particular, can you think about:

- Do you have any further questions now that you have left the set-up appointment?
- In there anything else you thought could be covered to support your medicines taking?
- Were there any issues you thought should be addressed?

We'll then explore your thoughts on these in the interview in a couple of weeks.

Thoughts or questions from the set-up appointment

Date	Time	Thoughts/comments/questions

Thank you for taking part in the TIMELY Study. Over the next two weeks, please make a note of any thoughts, comments or questions you have when you receive messages from Alice or respond to her. Please record the date and time, so that we know which message you're thinking about.

Date	Time	Thoughts/comments/questions

Date	Time	Thoughts/comments/questions

Appendix 25 Topic guide for diary-interviews in co-design of intervention delivery with patients study

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Interview Topic Guide – Patients

The following guide outlines the key areas for exploration during the focus group.

Aims and objectives
The overall aim of this study is to obtain feedback on the live prototype experience for patients, which have been created as part of a new text message intervention to support adherence to medicines, delivered by community pharmacies.

This will include:

- Exploring their views on the initial consultation and intervention set-up
- How they felt about the messages received as part of the intervention
- Experiences of home monitoring (where applicable)
- Perceived impact of the intervention on medication taking

Introduction
Aim: To introduce the research and set the context for the proceeding discussion

- Re-introduce self: University of Sunderland, TIMELY study, why I am here
- Re-introduce the study: what it is about, who it is funded by
- Talk through key points
  - We want you to give us feedback on parts of the TIMELY intervention which have been designed so far – initial consultation, text messages received
  - We'll use your diary to facilitate part of the interview, then we'll move on to your more general thought about your experience
  - There are no right or wrong answers
  - The whole session will last between 20 and 30 minutes
  - You don't have to answer all of the questions if you don't want to
  - Participation is voluntary and participant can withdraw at any time
- Confidentiality/ anonymity
  - In report writing, any quotes won't be identified as being you
- The interview will be audio recorded and I also may take some notes
  - The recording will be kept secure, only accessed by the four researchers working on the project, and will be kept for 10 years as per policy
- This piece of paper is just to help me remember what questions I want to ask you
- Do you have any questions?

1. Initial consultation
Aim: to gain feedback on the medicines use review / questionnaire / set up experience

Questions / prompts:

- What did you think about the initial medication review and text message set up?
  - Did you have any further information needs after you left the appointment?
- How did you feel about the coverage of information and advice provided about your medicines taking?
  - Were there any issues that you felt weren't addressed?

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

2. Patient diary

Aim: To discover how patients felt about the messages they received in the trial intervention

Questions / prompts

- Would you like to look through your diary and highlight any messages that stood out for you (good or bad)?
  - Why did you pick this one?
  - What was good or bad about it?
  - What do you think could be improved about "bad" messages?
  - Explore any messages highlighted from diary analysis
  - Explore any of the 'Level 2' messages sent
- How did the messages affect how you used your medicines?
- How did the messages affect how you felt/thought about your medicines?
- How did you feel about the level of information provided?
- How did you feel about the number of messages you received?

3. Home monitoring (if applicable)

Aim: To find out how any home monitoring messages are received and acted upon by patients

Questions / prompts

- Did you do any home monitoring for your long term condition before taking part in this trial?
- How did you find using the home monitoring equipment?
  - Was there any additional information that could have been provided initially to support you with this?
- How did you find texting monitoring results to Flo?
  - Did the format of the text message response make sense?
  - Was it clear what you had to send?
  - Did you have any errors?
- How did you find Flo's responses to your monitoring results?
  - Were they easy or difficult were these to understand?
  - Did you find these helpful, were there any that you felt were unhelpful?

4. Non-intervention LTCs (if applicable)

Aim: To explore how participants feel when the intervention doesn't explore all of their LTCs

Questions / prompts

- Explore impact of receiving text messages on perceptions of LTCs not covered by the intervention
- How did not receiving text messages for your LTCs affect how you felt about them?
- Which LTCs would you have found it helpful to be included in the intervention? Why? How would you envisage them being included?

5. General thoughts on the intervention

Aim: to explore potential efficacy of the intervention

Questions / prompts

- How did you feel that receiving these text messages supported you with your medication for your long term conditions?
- How did the content of the intervention feel in relation to your own perceptions of your medicines and your LTCs?
- What impact do you think receiving the text messages has had? Why do you think that?
    - Helpful/unhelpfulness
- Is there anything you think should be changed?
    - Are there any questions you still have / issues that weren't addressed that you think should be?

Next steps

- Thank the participant
- Do they have any remaining questions about the research
- Reassurance around confidentiality and anonymity
- Provide gift voucher
- Ask if they would like to know the results of the research – best way to do this

Appendix 26 Ethical approval letter from University of Sunderland for co-design of intervention delivery with patients study

Ms Gemma Donovan
School of Pharmacy and Pharmaceutical Sciences

Dear Gemma

PROJECT TITLE: A TEXT MESSAGE INTERVENTION TO SUPPORT APPROPRIATE MEDICINES ADHERENCE MOBILISED THOUGH NHS COMMUNITY PHARMACY (TIMELY) Phase 2 Study with Patients
APPLICATION: Reference Number 005298

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 25/10/2019 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 005298 (form submission date: 21/10/2019); (expected project end date: 13/12/2019).
- Participant information sheet 1009523 version 1 (21/10/2019).
- Participant consent form 1009524 version 1 (21/10/2019).

If during the course of the project you need to deviate significantly from the above-approved documentation please email ethics.review@sunderland.ac.uk

For more information please visit: https://www.sunderland.ac.uk/research/governance/researchethics/

Yours sincerely

Dr John Fulton
Ethics Administrator
University of Sunderland

Appendix 27 Invitation letter for co-design of intervention delivery with community pharmacy study

School of Pharmacy and Pharmaceutical Sciences
Faculty of Health Sciences and Wellbeing
University of Sunderland
Sciences Complex
Wharncliffe Street
Sunderland
SR1 3SD

DATE

Dear Colleague,

WE WOULD LIKE TO ASK FOR YOUR HELP

We would like to invite you to take part in a research study called the TIMELY study which is being done at the University of Sunderland. It aims to explore what professionals who support patients taking medicines for long term conditions, think about using text messages to help them. We know that a lot of people can struggle to take the right medicine, at the right time, in the right way, and we think that text messages personalised to them and their medicines might help. We're using a system made by Simple Telehealth, to deliver the new service.

We've designed some materials that we'd like you to review these for us. These are tools for supporting the delivery of the new intervention we've designed for community pharmacies. Taking part involves coming along to a focus group with one other colleague, where you'll meet up with people from other pharmacies to test out these tools. We have already organised this focus group to take place on the following date.

If you would like to take part in this study or want to know more about it, please read the information sheet which comes with this letter.

The focus group will take place on:

Date and Time
Location

A supper will be provided on arrival.

Kind regards,

Gemma Donovan
On behalf of the TIMELY team

Appendix 28 Participant information sheet for co-design of intervention delivery with community pharmacy study

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Information Sheet for Pharmacy Staff

You have been invited to take part in a research study. Before you decide, we would like you to understand why the research is being done, and what it will involve for you. Please read this information sheet and feel free to contact the team of researchers for this project (contact details at the end of sheet) if you have any questions.

The purpose of the research
This research aims to discover the views of patients, prescribers and pharmacists about using text messages as a potential tool to support adherence to medicines. We're planning to use Simple Telehealth as a platform for delivering the text message service. We have developed a number of materials to demonstrate how a new intervention might be delivered from a community pharmacy environment, and are looking for feedback in order to further improve the design.

Why have I been chosen to take part?
In our Phase 1 study, participants identified that it would be beneficial for the full pharmacy team to be involved in delivering the new next message intervention. So, for this Phase 2 study, we want to recruit pairs of pharmacy staff to test out some of the tools we have created to help deliver the new intervention. In each pair, we would like a pharmacist, and any other non-pharmacist member of the team. This could be a pharmacy technician, dispensing assistant or counter assistant. We want to make sure that we're considering the whole pharmacy team.

What will happen to me if I take part?
Taking part in this research involves taking part in a face-to-face focus group with other pharmacy staff from different pharmacies. As part of the focus group you will be asked in pairs with your colleague to:

- Review and provide feedback on a draft eLearning programme
- Have a go at using some software, facilitated by a draft pharmacy manual
- Use a draft 'implementation tool' to plan how you would set up the new intervention for medication adherence from your pharmacy

After each of these tasks, we'll ask you to tell us what worked, and what you think needs to change. We'll discuss the different changes people have suggested and also ask you to vote for which of these you think is the most important.

We'll also send you the pharmacy manual in advance, so if you want to you can have a look at it before the focus group.

We think the focus group will last between around 1½ hours. We will record it all so that we make sure that we have an accurate record of the feedback we receive from you and to make changes to the materials that are presented. We'll also collect in any written notes that you make on the day, to make sure that we don't miss anything. We'll also check what was entered in the software to see if you were able to use it as we expected with the information you were given. This is important to help us understand if you had all the information you needed, or whether more or different types of training might be needed.

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Confidentiality and anonymity
The audio files we record with be converted into a written document (transcript). All transcripts will be anonymised and your identity will not be revealed anywhere including in the reports of the research. Your data will be stored only on password protected computers and any paper based data will be stored in locked cupboards in locked offices. Only those conducting the study will have access to your personal data and it will not be shared with anyone else. However, it may be that appropriate members of the University of Sunderland may be given access to your data for monitoring or audit of this study to ensure we are complying with standards and regulations. The software you will use will initially have some of your data, but this will be deleted after the focus group. What you say will not be able to be linked to your name or organisation.

What are the potential disadvantages or risks from taking part?
No disadvantages or risks have been identified to you from taking part.

What are the possible benefits of taking part?
There are no direct benefits to yourself from taking part, but you would be helping us to investigate a new approach to supporting adherence to medicines for patients and the NHS.

Right to refuse or withdraw
Participation in this research is voluntary. If you agree to take part, we will ask you to sign a consent form. Even if you sign this consent form, you are free to withdraw at any time, without giving a reason. This would not affect your relationship with either the researcher or the University of Sunderland. However, once the study is complete and the results have been published, there will not be an opportunity for you to withdraw your data.

Outcomes of the research
The information we get from this study will help improve our intervention, ready for another testing phase. This will be what we call a 'feasibility study' which will find out whether this intervention can be tested in a clinical trial. There will be an option to an express and interest in the next phase of the research, but there is no commitment to this by taking part in this phase.

Who is undertaking the research?
The research is being undertaken by a research team at the University of Sunderland. The Chief Investigator for the project is Gemma Donovan, Academic Practitioner in the School of Pharmacy and Pharmaceutical Sciences at the University of Sunderland.

What happens to my data?
The University of Sunderland is the sponsor for this study based in the United Kingdom. We will be using information from you which you will provide in the consent form, focus group recording, and voting sheet, in order to undertake this study and will act as the data controller. This means that we are responsible for looking after your information and using it properly. The University of Sunderland will keep identifiable information about you until the end of the study for audit purposes only, after which it will be destroyed.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you

withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

You can find out more about how we use your information by contacting Gemma Donovan.

Expenses and payment
There are no payments available for participation.

Funding
The research is being supported by the National Institute of Health Research who have funded the project.

Approval
This study has been reviewed and by the University of Sunderland Research Ethics Committee and the Health Research Authority.

Who can I talk to if I have more questions about the research?
If you have any questions, want more information about the study or if you have any concerns about the research, you can contact the research team. This can either by email on Gemma.Donovan@sunderland.ac.uk or by phone on 0191 5152396 or on 07971 061447 between Monday to Friday.

You can also contact the Chair of the University of Sunderland Research Ethics Committee, Dr John Fulton, on john.fulton@sunderland.ac.uk or 0191 515 2529.

What to do if you wish to take part
If you would like to take part, please complete and return the attached consent form. A member of the research team with then be in touch to arrange which focus group you can attend.

Thank you for taking the time to read this information sheet.
We look forward to hearing from you.

Appendix 29 Participant consent form for co-design of intervention delivery with community pharmacy study

Private and Confidential

Participant Ref: _____

Pharmacy Participant Consent Form

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

	Please **initial all** of the following seven boxes
1. I confirm that I have read and understand the 'Participant Information Sheet' dated 10/06/19 (version 1) for the above study and have had the opportunity to ask questions.	
2. I understand that I will be asked take part in one focus group with other healthcare professionals which will be audio-recorded.	
3. I understand that the participation is voluntary and that I am free to withdraw at any time, without giving any reason, without any negative consequences.	
4. I understand that the information collected during the focus group will be made anonymous so as to not reveal my identity to anyone other than the research team.	
5. In understand that my name, email address and phone number will be used to create a temporary access to a software system, which will be changes to non-identifiable information after the focus group	
6. I understand that my words may be quoted anonymously in publications, reports, webpages and other research outputs.	
7. I agree to take part in the study.	

Name of participant (please print): _____

Please provide your contact details to confirm your focus group attendance and user account set-up for the software you will be testing.

Email address: _____

Phone number: _____

Signature of participant: _____ Date: _____

Signature of researcher: _____ Date: _____

Appendix 30 Focus group topic guide for co-design of intervention delivery with community pharmacy study

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Focus Group Topic Guide – Community Pharmacy

The following guide outlines the key areas for exploration during the focus group.

Aims and objectives
The overall aim of this study is to obtain feedback on prototypes which have been created as part of a new text message intervention to support adherence to medicines, delivered by community pharmacies.

This will include:

- How well a pharmacy manual can support training to set up the intervention
- What should be included in an eLearning programme for pharmacy staff
- Whether an implementation tool might help set up the new service for delivery

Introduction
Aim: To introduce the research and set the context for the proceeding discussion

- Introduce self and Nicky: University of Sunderland, TIMELY study, why I am here
- Introduce the study: what it is about, who it is funded by
- Talk through key points
  - We want you to give us feedback on parts of the TIMELY intervention which have been designed so far
  - You will be introduced to an aspect of the design
  - We'll ask you to take a look at these, interact with them and write down what you like and don't like about each of these
  - We'll then get you to share what you think and have a discussion
  - There are no right or wrong answers
  - The whole session will last around 1½ hours
  - If you need to leave at any time during the session, feel free to do so
  - You don't have to answer all of the questions if you don't want to
  - Participation is voluntary and participant can withdraw at any time
- Confidentiality/ anonymity
  - In report writing, any quotes won't be identified as being you
- The focus group will be audio recorded and Nicky will be observing and taking some notes
  - The recording will be kept secure, only accessed by the four researchers working on the project, and will be kept for 10 years as per policy
- This piece of paper is just to help me remember what questions I want to ask you
- Does anyone have any questions before we start?

During supper:

- User set-up for the software

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

1. Prototype 1: eLearning programme

Aim: to gain feedback on the proposed eLearning programme for TIMELY

Actions:

- Introduce the eLearning prototype –what feedback we are looking for
- Ask the participants to study the slides for themselves, alongside the suggested videos and invite professionals to write on the materials as they read if they would like to
- Silent generation of ideas
    - What do you think about the content in the programme, is there anything else you think needs to be included?
    - What do you think about the format – eLearning, videos
- Changes to be captured on post-it notes, themed
- Discussion and ranking

2. Prototype 2: Using the pharmacy manual to set-up a mock patient

Aim: To discover whether a pharmacy manual can train pharmacists to set up a new patient

Actions:

- Introduce the pharmacy manual – in particular 'questionnaire' and 'setting up a new patient'
- Talk through mock completed questionnaire
- Explain the task to try setting up a new patient, using the manual
- Ask if anything isn't clear
- Silent generation of ideas
    - How did you find using the manual?
    - Was the questionnaire easy to interpret?
    - Is there anything else you would like to learn to do this?
- Changes to be captured on post-it notes, themed
- Discussion and ranking

3. Prototype 2: The remainder of the pharmacy manual

Aim: To discover whether the remaining contents of the pharmacy manual will support delivering the TIMELY intervention

Actions:

- Ask participants to review the remaining contents of the pharmacy manual
- Silent generation of ideas
    - Is there any additional information you would need?
    - What format(s) would this be best provided in?
- Changes to be captured on post-it notes, themed
- Discussion and ranking

4. Prototype 3: Using the implementation tool

Aim: to ascertain whether an implementation tool can facilitate pharmacy set-up for delivery

Actions:

- Introduce the implementation tool, ask the participants to complete the tool for their own pharmacy teams if they were to set up the
- Silent generation of ideas
  - Would this prompt consideration of all the relevant points ready for implementation?
  - What format(s) would this be best provided in?
  - Would the monitoring motivate the team to continue engaging in delivery?
  - How easy or difficult would it be to monitor those criteria?
- Changes to be captured on post-it notes, themed
- Discussion and ranking

Next steps

- Thank the participants
- Do they have any remaining questions about the research
- Reassurance around confidentiality and anonymity
- They will also be asked if they would like to sign up as a site to deliver the feasibility study

Appendix 31 Ethical approval from University of Sunderland for co-design of intervention delivery with community pharmacy and general practice studies

University of Sunderland

Downloaded: 30/12/2021
Approved: 12/07/2019

Ms Gemma Donovan
School of Pharmacy and Pharmaceutical Sciences

Dear Gemma

PROJECT TITLE: TIMELY Phase 2 Prototyping Professionals
APPLICATION: Reference Number 004613

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 12/07/2019 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 004613 (form submission date: 12/07/2019); (expected project end date: 02/08/2019).
- Participant information sheet 1008778 version 2 (12/07/2019).
- Participant information sheet 1008777 version 2 (12/07/2019).
- Participant consent form 1008780 version 2 (12/07/2019).
- Participant consent form 1008779 version 3 (12/07/2019).

If during the course of the project you need to deviate significantly from the above-approved documentation please email ethics.review@sunderland.ac.uk

For more information please visit: https://www.sunderland.ac.uk/research/governance/researchethics/

Yours sincerely

Hailey James
Ethics Administrator
University of Sunderland

Appendix 32 Health Research Authority approval letter for the co-design of intervention delivery with pharmacy and general practice studies

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

NHS
Health Research Authority

Ms Gemma Donovan
Sciences Complex
Wharncliffe Street
Sunderland
SR1 3SD

Email: hra.approval@nhs.net
HCRW.approvals@wales.nhs.uk

12 July 2019

Dear Ms Donovan

HRA and Health and Care Research Wales (HCRW) Approval Letter

Study title:	**A text message intervention to support appropriate adherence to medicines from community pharmacy (TIMELY) - Prototyping study of the new intervention Phase 2 Professionals**
IRAS project ID:	**266603**
REC reference:	**19/HRA/4119**
Sponsor	**University of Sunderland**

I am pleased to confirm that **HRA and Health and Care Research Wales (HCRW) Approval** has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

Please now work with participating NHS organisations to confirm capacity and capability, in line with the instructions provided in the "Information to support study set up" section towards the end of this letter.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?
HRA and HCRW Approval does not apply to NHS/HSC organisations within Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report (including this letter) have been sent to the coordinating centre of each participating nation. The relevant national coordinating function/s will contact you as appropriate.

Please see IRAS Help for information on working with NHS/HSC organisations in Northern Ireland and Scotland.

How should I work with participating non-NHS organisations?
HRA and HCRW Approval does not apply to non-NHS organisations. You should work with your non-NHS organisations to obtain local agreement in accordance with their procedures.

What are my notification responsibilities during the study?

The attached document *"After HRA Approval – guidance for sponsors and investigators"* gives detailed guidance on reporting expectations for studies with HRA and HCRW Approval, including:

- Registration of Research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics and is updated in the light of changes in reporting expectations or procedures.

Who should I contact for further information?
Please do not hesitate to contact me for assistance with this application. My contact details are below.

Your IRAS project ID is **266603**. Please quote this on all correspondence.

Yours sincerely,
Aliki Sifostratoudaki

Approvals Specialist

Email: hra.approval@nhs.net

Copy to: *Mr Martin Finlayson, Sponsor contact*

Appendix 33 Participant invitation letter for co-design of intervention delivery with general practice study

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Department of Pharmacy and Pharmaceutical Sciences
Faculty of Health Sciences and Wellbeing
University of Sunderland
Sciences Complex
Wharncliffe Street
Sunderland
SR1 3SD

DATE

Dear Colleague,

WE WOULD LIKE TO ASK FOR YOUR HELP

We would like to invite you to take part in a research study called the TIMELY study which is being done at the University of Sunderland. It aims to explore what professionals who support patients taking medicines for long term conditions, think about using text messages to help them. We know that a lot of people can struggle to take the right medicine, at the right time, in the right way, and we think that text messages personalised to them and their medicines might help. We're using a system made by Simple Telehealth, to deliver the new service.

We've designed some materials that we'd like you to test out for us. These are communications and information for general practice about the intervention. Taking part involves coming along to a group discussion with other healthcare professionals. We have already organised this focus group to take place on the following date.

If you would like to take part in this study or want to know more about it, please read the information sheet which comes with this letter.

The focus group will take place on:

Date and Time
Location

Kind regards,

Gemma Donovan
On behalf of the TIMELY team

Appendix 34 Participant information sheet for co-design of intervention delivery with general practice study

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Information Sheet for General Practice

You have been invited to take part in a research study. Before you decide, we would like you to understand why the research is being done, and what it will involve for you. Please read this information sheet and feel free to contact the team of researchers for this project (contact details at the end of sheet) if you have any questions.

The purpose of the research
This research aims to discover the views of patients, prescribers and pharmacists about using text messages as a potential tool to support adherence to medicines. We're planning to use Simple Telehealth as a platform for delivering the text message service. We have developed a number of materials to demonstrate what a new text message service for medication adherence might look like, and are looking for feedback in order to further improve the design.

Why have I been chosen to take part?
Any healthcare professional involved in supporting patients with their medicines can take part.

What will happen to me if I take part?
Taking part in this research involves taking part in a face-to-face focus group with other healthcare professionals. The materials that will be presented for feedback include:

- An example notification from community pharmacy that a patient has been set up to receive text messages
- A website which will contain information for general practice
- A template protocol document which details the text messages for patients

We think this will last around 1 hour. We will record it all so that we make sure that we have an accurate record of the feedback we receive to make changes to the materials that are presented. We'll also collect in any written notes that you make on the day, to make sure that we don't miss anything. For each of the materials we will capture some changes and vote on which of these you consider to be most important.

Confidentiality and anonymity
All transcripts will be anonymised and your identity will not be revealed anywhere including in the reports of the research. Your data will be stored only on password protected computers and any paper based data will be stored in locked cupboards in locked offices. Only those conducting the study will have access to your personal data and it will not be shared with anyone else. However, it may be that appropriate members of the University of Sunderland may be given access to your data for monitoring or audit of this study to ensure we are complying with standards and regulations. What you say will not be able to be linked to your name.

What are the potential disadvantages or risks from taking part?
No disadvantages or risks have been identified to you from taking part.

What are the possible benefits of taking part?
There are no direct benefits to yourself from taking part, but you would be helping us to investigate a new approach to supporting adherence to medicines for patients and the NHS.

Funded and supported by NHS National Institute for Health Research

University of Sunderland

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Right to refuse or withdraw
Participation in this research is voluntary. If you agree to take part, we will ask you to sign a consent form. Even if you sign this consent form, you are free to withdraw at any time, without giving a reason. This would not affect your relationship with either the researcher or the University of Sunderland. However, once the study is complete and the results have been published, there will not be an opportunity for you to withdraw your data.

Outcomes of the research
The information we get from this study will help improve our intervention, ready for another testing phase. This will be a feasibility study to see if an evaluation of this intervention can be conducted.

Who is undertaking the research?
The research is being undertaken by a research team at the University of Sunderland. The Chief Investigator for the project is Gemma Donovan, Academic Practitioner in the School of Pharmacy and Pharmaceutical Sciences at the University of Sunderland.

What happens to my data?
The University of Sunderland is the sponsor for this study based in UK. We will be using information from you in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. The University of Sunderland will keep identifiable information about you until the end of the study in November 2019. Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will destroy the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible. You can read the University of Sunderland policies on information governance here: https://ts.sunderland.ac.uk/csig/information-governance/ or contact our Data Protection Officer Sam Seldon if you have any questions on dataprotection@sunderland.ac.uk or by telephone on 0191 515 2040.

Expenses and payment
There are no payments available for participation.

Funding
The research is being supported by the National Institute of Health Research who have funded the project.

Approval
This study has been reviewed and approved by the University of Sunderland Research Ethics Committee and the Health Research Authority.

Who can I talk to if I have more questions about the research?
If you have any questions, want more information about the study or if you have any concerns about the research, you can contact the research team. This can either by email on Gemma.Donovan@sunderland.ac.uk or by phone on 0191 5152396 or on 07971 061447

between Monday to Friday.

You can also contact the Chair of the University of Sunderland Research Ethics Committee, Dr John Fulton, on john.fulton@sunderland.ac.uk or 0191 515 2529.

What to do if you wish to take part

If you would like to take part, please complete and return the attached consent form. A member of the research team with then be in touch to arrange which focus group you can attend.

Thank you for taking the time to read this information sheet.
We look forward to hearing from you.

Appendix 35 Participant consent form for co-design of intervention delivery with general practice study

Private and Confidential

Participant Ref: _____

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General Practice Participant Consent Form

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

	Please **initial all** of the following six boxes
1. I confirm that I have read and understand the 'Participant Information Sheet' dated 10/06/19 (version 1) for the above study and have had the opportunity to ask questions.	
2. I understand that I will be asked take part in one focus group with other healthcare professionals which will be audio-recorded.	
3. I understand that the participation is voluntary and that I am free to withdraw at any time, without giving any reason, without any negative consequences.	
4. I understand that the information collected during the focus group will be made anonymous so as to not reveal my identity to anyone other than the research team.	
5. I understand that my words may be quoted anonymously in publications, reports, webpages and other research outputs.	
6. I agree to take part in the study.	

Name of participant (please print): _____

Please provide your contact details so that we are able to get in touch with you to arrange which focus group you are able to attend.

Email address: _____

Phone number: _____

Signature of participant: _____ Date: _____

Signature of researcher: _____ Date: _____

Appendix 36 Focus group topic guide for co-design of intervention delivery with general practice study

Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

Focus Group Topic Guide – General Practice

The following guide outlines the key areas for exploration during the focus group.

Aims and objectives
The overall aim of this study is to obtain feedback on prototypes which have been created as part of a new text message intervention to support adherence to medicines, delivered by community pharmacies.

This will include:

- What information should be included in a notification letter to general practice that one of their patients is receiving text messages to support adherence to medicines
- What is the most appropriate layout and content for details of the intervention to be made available on a website

Introduction
Aim: To introduce the research and set the context for the proceeding discussion

- Introduce self and Nicky: University of Sunderland, TIMELY study, why I am here
- Introduce the study: what it is about, who it is funded by
- Talk through key points
    - We want you to give us feedback on parts of the TIMELY intervention which have been designed so far
    - You will be introduced to an aspect of the design
    - We'll ask you to take a look at these, interact with them and write down what you like and don't like about each of these
    - We'll then get you to share what you think and have a discussion, and vote for which changes you think are most important
    - There are no right or wrong answers
    - The whole session will last between 60 and 90 minutes
    - If you need to leave at any time during the session, feel free to do so
    - You don't have to answer all of the questions if you don't want to
    - Participation is voluntary and participant can withdraw at any time

- Confidentiality/ anonymity
    - In report writing, any quotes won't be identified as being you
- The focus group will be audio recorded and Nicky will be observing and taking some notes
    - The recording will be kept secure, only accessed by the four researchers working on the project, and will be kept for 10 years as per policy
- This piece of paper is just to help me remember what questions I want to ask you
- Does anyone have any questions?

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Study title: A text message intervention to support appropriate medicines adherence mobilised through community pharmacy (TIMELY)

1. Prototype 1: GP notification letter

Aim: to gain feedback on a prototype notification letter to general practice

Actions:

- Introduce the notification letter prototype including automated content (from PharmOutcomes) and transmission method (to nhs.net) –what feedback we are looking for
- Ask the participants to study the letter for themselves
- Silent generation of ideas
    - What do you think about the content in the letter, is there anything else you think needs to be included?
    - Does the format / delivery method match what you would want for adding information to your practice record?
- Changes captured on post-it notes, discussion
- Ranking

2. Prototype 2: Using the TIMELY website

Aim: To discover whether a website supports providing the information that might be needed by general practice staff for

Actions:

- Introduce the website – what feedback are we looking for
- Ask the participants to study the website for themselves
- Silent generation of ideas
    - Were you able to find the information you wanted? How easy or difficult was this?
- Changes captured on post-it notes, discussion
- Ranking

3. Prototype 3: Protocol document

Aim: To discover whether a protocol document provides sufficient information for GP staff

Actions:

- Introduce the protocol document, explain that this is only a sample for a template (not complete) – what feedback are we looking for
- Ask the participants to study the website for themselves
- Silent generation of ideas
    - Would this support you to take the action that you wanted to take if you were presented with a query from a patient about the intervention?
- Changes captured on post-it notes, discussion
- Ranking

Next steps

- Thank the participants
- Do they have any remaining questions about the research
- Reassurance around confidentiality and anonymity